HONORABLE MICHELLE L. PETERSON

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

| | |
|---|---|
| WILD FISH CONSERVANCY,<br><br>Plaintiff,<br><br>v.<br><br>BARRY THOM, *et al.*,<br><br>Defendants,<br><br>and<br><br>ALASKA TROLLERS ASSOCIATION; and STATE OF ALASKA,<br><br>Defendant-Intervenors. | Case No. 2:20-cv-00417-RAJ-MLP<br><br>THIRD DECLARATION OF BRIAN A. KNUTSEN |

I, Brian A. Knutsen, declare the following on the basis of personal knowledge to which I am competent to testify:

1. I am co-counsel for Plaintiff Wild Fish Conservancy ("Conservancy") in this litigation;

2. Attached hereto as Exhibit 1 is a true and accurate copy of a Freedom of Information Act ("FOIA") request I sent to the National Marine Fisheries Service ("NMFS")



KAMPMEIER & KNUTSEN PLLC
1300 S.E. Stark Street, Suite 202
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

entitled "Freedom of Information Act Request for Records Related to Hatchery Production Intended to Benefit Southern Resident Killer Whales" and dated January 13, 2021 ("FOIA Request");

3. Attached hereto as Exhibit 2 is a true and accurate copy of a FOIA response I received from NMFS entitled "Request No. DOC-NOAA-2021-000952." The letter indicates that NMFS has located 12 records responsive to the FOIA Request and is releasing those records to me in their entirety;

4. Attached hereto as Exhibit 3 is a true and accurate copy of a record I received from NMFS in response to the FOIA Request entitled "One Summer Chinook Salmon Hatchery Program in the Upper Columbia River Basin, WA-Decision Memorandum" and dated May 15, 2020;

5. Attached hereto as Exhibit 4 is a true and accurate copy of a record I received from NMFS in response to the FOIA Request labeled "4(d) Rule Limit 5 Evaluation and Recommended Determination" and dated May 8, 2020;

6. Attached hereto as Exhibit 5 is a true and accurate copy of a record I received from NMFS in response to the FOIA Request directed to Mr. Kelly Susewind and Mr. Shane Bickford and dated May 15, 2020;

7. Attached hereto as Exhibit 6 is a true and accurate copy of a record I received from NMFS in response to the FOIA Request entitled "Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation" and dated May 11, 2020;

8. Attached hereto as Exhibit 7 is a true and accurate copy of a record I received from NMFS in response to the FOIA request entitled "Supplemental Environmental Assessment



KAMPMEIER & KNUTSEN PLLC
1300 S.E. Stark Street, Suite 202
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

of the Wells Summer Chinook Hatchery and Genetic Management Plan" and dated May 15, 2020;

9. Attached hereto as Exhibit 8 is a true and accurate copy of a record I received from NMFS in response to the FOIA request labeled "FONSI for Wells Summer Chinook Salmon HGMP" and dated January 27, 2020;

10. Attached hereto as Exhibit 9 is a true and accurate copy of a record I received from NMFS in response to the FOIA request entitled "Record of Decision for the Final Environmental Impact Statement for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin" and dated May 15, 2020;

11. Attached hereto as Exhibit 10 is a true and accurate copy of a record I received from NMFS in response to the FOIA request labeled "4(d) Rule Limit 6 Evaluation and Recommendation" and dated January 30, 2020;

12. Attached hereto as Exhibit 11 is a true and accurate copy of a record I received from NMFS in response to the FOIA request entitled "Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation" and dated April 15, 2019 (excerpts);

13. Attached hereto as Exhibit 12 is a true and accurate copy of a record I received from NMFS in response to the FOIA request entitled "Final Environmental Impact Statement for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin" and dated July 2019 (excerpts);

14. Attached hereto as Exhibit 13 is a true and accurate copy of a record I received from NMFS in response to the FOIA request entitled "Pacific Salmon Treaty Production



KAMPMEIER & KNUTSEN PLLC
1300 S.E. Stark Street, Suite 202
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

Increases at Spring Creek NFH Little White Salmon NFH, and Willard NFH for Brood Years 2020" and dated October 21, 2020;

15. Attached hereto as Exhibit 14 is a true and accurate copy of a record I received from NMFS in response to the FOIA request entitled "Pacific Salmon Treaty Production Increases at the Little White Salmon NFH, for Brood Year 2020" and dated October 21, 2020;

16. Exhibits 3 through 14 comprise a full and complete copy of the 12 records I received from NMFS in response to the FOIA Request.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed this 9th day of June, 2021 at Portland, Oregon.

s/ Brian A. Knutsen
Brian A. Knutsen, WSBA No. 38806



KAMPMEIER & KNUTSEN PLLC
1300 S.E. Stark Street, Suite 202
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

# Exhibit 1

KAMPMEIER & KNUTSEN PLLC

ATTORNEYS AT LAW

BRIAN A. KNUTSEN
Licensed in Oregon & Washington
503.841.6515
brian@kampmeierknutsen.com

January 13, 2021

**Via Email**
National Marine Fisheries Service Headquarters
Freedom of Information Act Office
Attn: Ryan McQuighan, NMFS Acting FOIA Liaison
1315 East-West Highway
Silver Spring, MD 20910
Email: Ryan.McQuighan@noaa.gov
FOIA@noaa.gov

**Re: Freedom Of Information Act Request for Records Related to Hatchery Production Intended to Benefit Southern Resident Killer Whales**

Dear Mr. McQuighan:

This is a request under the Freedom of Information Act ("FOIA"), 5 U.S.C. § 552, *as amended*. This request is submitted on behalf of Wild Fish Conservancy. Please let me know as soon as possible if you have any questions regarding the scope of this request. Please also respond to this request within the time allowed by law. Time is of the essence in receiving the requested materials.

Wild Fish Conservancy is a non-profit member-based environmental organization with approximately 2,400 members. Wild Fish Conservancy actively informs the public on matters affecting water quality, fish, and fish habitat and ecosystems in Washington and throughout the Pacific Northwest. Through publications, commentary to the press, sponsorship of educational programs and events, and the development of an institutional expertise regarding water quality, fish, and fish habitat, it has become very involved in the development of a statewide agenda for the protection of these resources. Wild Fish Conservancy has lobbied, litigated, and publicly commented on federal and other actions that affect waters in the Pacific Northwest.

This request concerns funding provided by and/or through the National Marine Fisheries Service ("NMFS") for new and/or increased hatchery production in an effort to benefit Southern Resident Killer Whales as described in the following document: Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska, NMFS Consultation No.: WCR-2018-10660 (April 5, 2019) ("2019 SEAK BiOp").

Pursuant to the FOIA, please provide Wild Fish Conservancy any communications, reports, memoranda, notes, applications, requests, proposals, summaries, evaluations, approvals, or similar documents in the custody or control of NMFS that were created, issued, received, or modified since January 1, 2018 related to NMFS's funding and/or proposed funding of new and/or increased hatchery production in an effort to benefit Southern Resident Killer Whales as described in the 2019 SEAK BiOp, including:

1. Any such materials related to requests for and/or distributions of funds;

2. Any such materials describing how the funds have been or will be used, including the number of fish produced or to be produced;

3. Any such materials related to communications or other efforts involving State, Tribal, U.S. Fish and Wildlife Service, or other entities that own, operate, and/or fund hatchery operations;

4. Any such materials related to NMFS's consideration and/or evaluation of hatchery programs for potential funding;

5. Any such materials related to National Environmental Policy Act procedures for the funding and/or the new and/or increased hatchery production;

6. Any such materials related to Endangered Species Act section 7 consultation and/or other Endangered Species Act review and/or "take authorization" for the funding and/or the new and/or increased hatchery production; and

7. Any such materials involving communications with Eric Kinne.

Materials provided to Wild Fish Conservancy in response to its similar FOIA request to NMFS dated May 27, 2020 are excluded from this request.

Wild Fish Conservancy is willing to accept any or all of the requested documents in electronic or printed format. You may provide the information to me electronically at brian@kampmeierknutsen.com or on CD-ROM by mail to: Brian Knutsen, Kampmeier & Knutsen, PLLC, 1300 S.E. Stark Street, Suite 202, Portland, Oregon 97214.

Wild Fish Conservancy requests that all fees be waived because "disclosure of the information is in the public interest . . . and is not primarily in the commercial interest of the requestor." 5 U.S.C. 552(a)(4)(A)(iii). Wild Fish Conservancy is seeking this information in order to better understand and help the public understand NMFS's funding of hatchery in an effort to Southern Resident Killer Whales. Release of the requested information is in interest of the general public in that it will further an understanding of the efficacy of fish hatcheries, hatcheries' relationship to Southern Resident Killer Whales, and NMFS's roles in hatchery programs throughout the Pacific Northwest.

*1. The records concern the operations or activities of the Government.*

The FOIA request is, by its terms, limited to identifiable operations and activities of the Government. As described in the 2019 SEAK BiOp, NMFS intends to administer a grant program whereby it will disburse funds appropriated by Congress to support new and increased hatchery production. This is an activity of the Government.

*2. The release of the requested records is likely to contribute significantly to public understanding of government operations.*

The requested documents concern, *inter alia*, NMFS's administration of a grant program that will disburse funds appropriated by Congress for the production of hatchery fish in an effort to benefit Southern Resident Killer Whales, including National Environmental Policy Act and Endangered Species Act reviews for this program. These records will provide recent information underlying the agency's decision-making and use of federal funds with respect to fisheries, hatcheries, salmon abundance, and Southern Resident Killer Whales, will afford insight into the agency's decision-making processes, and highlight any competing viewpoints. These records will allow Wild Fish Conservancy and the public to understand and evaluate the agency's decision-making.

*3. The release of requested records will contribute significantly to public understanding of the governmental activities.*

Production of the records is likely to contribute significantly to public understanding of the operations or activities of the government. Wild Fish Conservancy has been studying issues related to salmon abundance, fisheries/harvests, hatcheries, and Southern Resident Killer Whales for many years and Wild Fish Conservancy regularly communicates its studies and findings to its members, the public, government officials, legislatures, industry groups, and other non-profit groups. For example, Wild Fish Conservancy provided public comments on the draft recovery plan for the Southern Resident Killer Whale. Wild Fish Conservancy (including its staff scientists) has published numerous articles on a variety of fishery and hatchery topics, including genetic effects from hatchery operations. Examples of recent publications include: Lichatowich, J., R. Williams, B. Bakke, J Myron, D. Bella, B. McMillan, J. Stanford, D. Montgomery, K. Beardslee and N. Gayeski. 2018. Wild Pacific Salmon: A Threatened Legacy. jalich@comcast.net. Expanded July 2018 version, printed by Bemis Printing, St. Helens, OR; Tuohy, A., Skalski, J., Gayeski, N., Survival of Salmonids from an Experimental Commercial Fish Trap, 44 FISHERIES 9 (Sept. 2019); Geyeski, N., Stanford, J., Montgomery, D., Lichatowich, J., Peterman, R., Williams, R., The Failure of Wild Salmon Management: Need for a Place-Based Conceptual Foundation, 43 FISHERIES 7 (July 2018). Wild Fish Conservancy recently published an opinion article on the use of hatchery to benefit killer whales: MacDuffee, M., Gayeski, N., Genovali, C., Opinion: More Salmon Hatcheries Will Not Help Killer Whales or Chinook, Vancouver Sun (July 12, 2019). Wild Fish Conservancy has recently given numerous presentations on the benefits of selective gear harvests and watershed management of fisheries to fishing organizations, First Nations, and community organizations.

In regards to the current request, Wild Fish Conservancy will use the requested documents to understand NMFS's use of federal funds for new and increased hatchery production in an effort to mitigate impacts of harvests and to benefit Southern Resident Killer Whales, including to understand NMFS's evaluations of hatcheries as mitigation, how NMFS determines which hatchery programs to fund, NMFS's understanding as to the extent of benefit provided by the hatchery programs, the costs needed for the hatchery mitigation programs, and NMFS's evaluation of impacts from the hatchery programs, including such impacts to threatened salmonids. Wild Fish Conservancy will then use this understanding to further the public's understanding of these very issues through a variety of mediums, including scientific articles, reports, public presentations, newsletters, public presentations, or other means.

Wild Fish Conservancy also maintains a website (http://wildfishconservancy.org/) to disseminate information free of charge to the public regarding the management of wild native fish and their hatchery-origin counterparts by NMFS and other governmental agencies. Wild Fish Conservancy publishes a detailed annual report of its activities and makes additional periodic electronic reports to its members (there are approximately 3,000 names on Wild Fish Conservancy's electronic mailing list). Wild Fish Conservancy's members have expressed interest in efforts to protect Southern Resident Killer Whales, so Wild Fish Conservancy is confident that a broad audience of persons will be interested in the subject of this request. The staff of Wild Fish Conservancy have expertise in this subject area and present findings of its activities to civic organizations throughout the year. In addition, Wild Fish Conservancy is represented on various committees and boards charged with restoration of watersheds and recovery of fish or ecosystems and the information gained will be communicated to the general public and interested parties through those venues as well. Lastly, Wild Fish Conservancy communicates regularly with other conservation groups and these groups often reciprocate and report on each other's findings. In short, Wild Fish Conservancy has a number of avenues from which to communicate this information to the public and will take advantage of all of them. Wild Fish Conservancy may also use the records to more effectively advocate for the restoration of native fish populations.

The very act of a local citizen group engaging in the review of agency records created or obtained during implementation of federal statutes is "in the public interest." The *per se* significance of the "citizen watchdog" function carried out by Wild Fish Conservancy is evident from federal law interpreting the FOIA. The fee waiver provision was adopted to facilitate access to agency records by what the Court described as "citizen watchdog" organizations. *See Better Gov't Ass'n v. Dep't of State*, 780 F.2d 86, 88-89 (D.C. Cir.1987).

This is information is meaningfully informative because, to the best of Wild Fish Conservancy's knowledge, this information is not otherwise available to the public or in the public domain, and this information will therefore significantly contribute to the public's understanding of the subject matter of the request.

*4. Disclosure would not serve a commercial interest of the requestor.*

Disclosure is in no way connected with any commercial interest of the requestor, as Wild Fish Conservancy is a nonprofit, nonpartisan public interest organization. The materials

discussed above that are produced by Wild Fish Conservancy, including publications, websites, comments, and newsletters, are freely available to the public at no cost. *See McClellan Ecological Seepage Situation v. Carlucci*, 835 F.2d 1282, 1284 (9th Cir. 1987) (noting that FOIA's fee waiver provision is to be "'liberally construed in favor of waivers for noncommercial requestors'" (quoting legislative history)).

Under the FOIA, NMFS must make a determination on Wild Fish Conservancy's request within 20 working days. 5 U.S.C. § 552(a)(6)(A)(i). A determination consists of a statement whether the agency will comply with request, the reasons therefor, and informs the requester of the right to appeal an adverse decision. Failure to respond in a timely manner shall be viewed as a denial of this request and the requestor may immediately file an administrative appeal.

If access to any of the requested records is denied, please note that the Freedom of Information Act provides that if only portions of a requested file are exempted from release, the remainder must still be released. I therefore request that I be provided with all non-exempt portions that are reasonably segregable. I further request that you describe the deleted material in detail and specify the statutory basis for the denial as well as your reasons for believing that the alleged statutory justification applies in this instance. Please separately state your reasons for not invoking your discretionary powers to release the requested documents in the public interest. Such statements will be helpful in deciding whether to appeal an adverse determination, and in formulating arguments in case an appeal is taken. Your agency's written justification might also help to avoid unnecessary litigation. I reserve our rights to appeal the withholding or deletion of any information and expect that you will list the office and address where such an appeal can be sent.

Please contact me if you have any questions about this request, particularly concerning the identity of the records requested. Thank you in advance for your assistance in this matter.

Very truly yours,

KAMPMEIER & KNUTSEN, PLLC

By: *s/ Brian A. Knutsen*
Brian A. Knutsen

# Exhibit 2

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

Brian Knutsen
Kampmeier and Knutsen PLLC
1300 SE Stark St Suite 202
Portland, OR 97214

Re: Request No. DOC-NOAA-2021-000952

Dear Mr. Knutsen,

This letter is in response to your Freedom of Information Act (FOIA) request which was received by our office on 3/8/2021, in which you requested:

"Pursuant to the FOIA, please provide Wild Fish Conservancy any communications, reports, memoranda, notes, applications, requests, proposals, summaries, evaluations, approvals, or similar documents in the custody or control of NMFS that were created, issued, received, or modified since January 1, 2018 related to NMFS's funding and/or proposed funding of new and/or increased hatchery production in an effort to benefit Southern Resident Killer Whales as described in the 2019 SEAK BiOp, including:
1. Any such materials related to requests for and/or distributions of funds;
2. Any such materials describing how the funds have been or will be used, including the number of fish produced or to be produced;
3. Any such materials related to communications or other efforts involving State, Tribal, U.S. Fish and Wildlife Service, or other entities that own, operate, and/or fund hatchery operations;
4. Any such materials related to NMFS's consideration and/or evaluation of hatchery programs for potential funding;
5. Any such materials related to National Environmental Policy Act procedures for the funding and/or the new and/or increased hatchery production;
6. Any such materials related to Endangered Species Act section 7 consultation and/or other Endangered Species Act review and/or "take authorization" for the funding and/or the new and/or increased hatchery production; and
7. Any such materials involving communications with Eric Kinne."

We have located 12 records responsive to your request, and we are releasing all 12 records to you in their entirety. This is our final response to your request.

You have the right to file an administrative appeal if you are not satisfied with our response to your FOIA request. All appeals should include a statement of the reasons why you believe the FOIA response was not satisfactory. An appeal based on documents in this release must be received within 90 calendar days of the date of this response letter at the following address:

Assistant General Counsel for Employment, Litigation, and Information
U.S. Department of Commerce

Office of General Counsel
Room 5896
14th and Constitution Avenue, N.W.
Washington, D.C. 20230

An appeal may also be sent by e-mail to FOIAAppeals@doc.gov, or by FOIAonline at https://foiaonline.regulations.gov/foia/action/public/home#.

For your appeal to be complete, it must include the following items:

- a copy of the original request,
- our response to your request,
- a statement explaining why the withheld records should be made available, and why the denial of the records was in error.
- “Freedom of Information Act Appeal” must appear on your appeal letter. It should also be written on your envelope, or e-mail subject line.

FOIA appeals posted to the e-mail box, FOIAOnline, or Office after normal business hours will be deemed received on the next business day. If the 90th calendar day for submitting an appeal falls on a Saturday, Sunday or legal public holiday, an appeal received by 5:00 p.m., Eastern Time, the next business day will be deemed timely.

FOIA grants requesters the right to challenge an agency's final action in federal court. Before doing so, an adjudication of an administrative appeal is ordinarily required.
The Office of Government Information Services (OGIS), an office created within the National Archives and Records Administration, offers free mediation services to FOIA requesters. They may be contacted in any of the following ways:

Office of Government Information Services
National Archives and Records Administration
Room 2510
8601 Adelphi Road
College Park, MD 20740-6001
Email: ogis@nara.gov

Phone: 301-837-1996
Fax: 301-837-0348
Toll-free: 1-877-684-6448

If you have questions regarding this correspondence, please contact Mr. Brailey Simplican at brailey.simplican@noaa.gov or the NOAA FOIA Public Liaison Tony Lavoi at (843) 740-1274.

Sincerely,

MARTIN.SHAWN.LAMONT.1171841646

Digitally signed by MARTIN.SHAWN.LAMONT.1171841646
Date: 2021.04.12 16:12:16 -07'00'

**Shawn Martin**
*Information Technology Specialist/*
*West Coast Region FOIA Team Lead*
*NOAA Fisheries West Coast Region*
*U.S. Department of Commerce*
Office: (916) 930-3792
Mobile:(916) 719-0293

# Exhibit 3

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
7600 Sand Point Way NE
SEATTLE, WA 98115

May 15, 2020

MEMORANDUM FOR: Barry A. Thom
Regional Administrator

FROM: Allyson Purcell
Chief, Anadromous Production and Inland Fisheries Branch
Sustainable Fisheries Division

SUBJECT: One Summer Chinook Salmon Hatchery Program in the Upper Columbia River Basin, WA-Decision Memorandum

The Washington Department of Fish and Wildlife (WDFW) and the Douglas County Public Utilities District (DPUD) have jointly submitted a Hatchery and Genetic Management Plan (HGMP) for a summer Chinook salmon hatchery program for Southern Resident Killer Whales in the Upper Columbia River Basin at Wells Hatchery. The HGMP was submitted for review under Limit 5 of the Endangered Species Act (ESA) 4(d) Rule, 50 CFR 223.203(b)(4).

## Recommendation

The National Marine Fisheries Service's (NMFS') Sustainable Fisheries Division (SFD) has evaluated the HGMP and finds that it meets all of the requirements specified in Limit 5 of the 4(d) Rule. SFD recommends that the HGMP be approved under Limit 5 of the 4(d) Rule, provided that the HGMP is operated in accordance with the implementation terms detailed at the end of this memo, and with the Proposed Action described in the Proposed Action section of NMFS' Biological Opinion.

## Background

An application prepared by the co-managers (Table 1) was received and deemed sufficient by NMFS in 2019 (NMFS 2019b). The activities included in this evaluation are described in the HGMP (WDFW 2019).

**Table 1. Application details for the hatchery program.**

| Hatchery and Genetics Management Plan | Program Operator[1] | Program Funder[1] |
|---|---|---|
| Wells Summer Chinook for SRKW[1] | Washington Department of Fish and Wildlife and Douglas PUD[2] | Washington Department of Fish and Wildlife[3] and/or Pacific Salmon Treaty Funds |

[1]SRKW = Southern Resident Killer Whales
[2] Public Utility District No. 1 of Douglas County
[3]This will not include funding for Douglas PUD's normal operating and maintenance costs associated with their existing program obligations. Douglas PUD owns and operates Wells Hatchery.

## Discussion

*Controversial Issues*

The activities described in the HGMP are not controversial, and are not the subject of on-going or pending litigation.

*Public Review and Comment*

NMFS has provided an opportunity for public comment on the Hatchery and Genetic Management Plan. This document was made available for a 30-day public comment period upon notice of availability in the Federal Register on January 7, 2020 (85 FR 704).

The Environmental Assessment (EA) that precedes the Supplemental EA (SEA) was also made available for a 30-day public comment period upon notice of availability in the Federal Register on April 2, 2029 (84 FR 12594). We received comments from two commenters. The comments were non-substantive and did not offer suggestions for improving the hatchery programs nor did they provide any supporting information or documentation for their critiques. None of the comments resulted in edits to the EA.

*Evaluation of the HGMP under the 4(d) Rules*

After considering public comments, SFD determined that the HGMP meets all of the requirements of the ESA 4(d) Rule. See Attachment 1 for our evaluation.

*Evaluation of NMFS' Proposed Determination under NEPA*

SFD published a Supplemental Environmental Assessment (SEA) (Attachment 2) to modify an existing EA (NMFS 2019a) and evaluate whether NMFS' 4(d) determination would result in significant environmental impacts. The SEA also evaluated the effects of terminating all HGMP activities, reducing production, and increasing production. SFD prepared a Finding of No Significant Impact (FONSI) (Attachment 3).

*Evaluation of Federal Actions under the ESA Section* 7 *and the Magnuson-Stevens Act EFH*

SFD prepared an ESA section 7 Biological Opinion to evaluate the effects of our determination on listed species in the Action Area (Attachment 4). As described in SFD's Biological Opinion, the approval of the HGMP is not likely to jeopardize the continued existence of the listed Upper Columbia River Spring Chinook Salmon ESU or Steelhead DPS, the Southern Resident Killer Whale DPS, nor would it result in the destruction or adverse modification of their critical habitat.

SFD also analyzed the effects of the actions on Essential Fish Habitat (EFH) under the Magnuson-Stevens Act in our Biological Opinion. We determined that the effects of the action on EFH are likely to be within the range of effects considered in the ESA portion of the opinion, and concluded that the proposed actions are not likely to have any additional adverse effects on Pacific salmon EFH.

NMFS engaged in a separate consultation with the USFWS on ESA-listed species under USFWS' jurisdiction (USFWS 2020).

*Implementation Terms*

To help ensure consistency with the NMFS effects findings and ESA determinations for the Proposed Action, the applicants must comply with the following implementation terms for the HGMP (NMFS provides these implementation terms to the applicant in a letter describing our final determination).

1) Provide advance notice of any change in program operation and implementation that may increase the amount or extent of take, or results in an effect of take not previously considered.
2) Notify NMFS SFD within 48 hours after knowledge of exceeding authorized take. The applicants shall submit a written report, and/or convene a discussion with NMFS to discuss why the authorized take was exceeded.
3) The applicants implement the Wells Summer Chinook Hatchery Program for Southern Resident Killer Whales program as described in the Proposed Action (Section 1.2) and the submitted HGMP including:
   a) Providing advance notice to NMFS of any change in hatchery program operation that potentially increases the amount or extent of take, or results in an effect of take not previously considered.
   b) Providing notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion.
   c) Allowing NMFS to accompany any employee or representative field personnel while they conduct activities covered by their biological opinion.
4) The applicants provide reports to NMFS SFD annually on December 31$^{st}$ a year after collection of data for the hatchery program and associated research, monitoring, and evaluation (RM&E).
   a) All reports/notifications be submitted electronically to the NMFS SFD point of contact for this opinion: Natasha Preston (503) 231-2178, *natasha.preston@noaa.gov*.
   b) Applicants will notify NMFS SFD within 48 hours after exceeding any authorized take, and shall submit a written report detailing why the authorized take was exceeded within two weeks of the event.
   c) Annual reports to SFD for hatchery programs should include:
      i) The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities Hatchery Environment Monitoring Report
         - Number and composition of broodstock, and dates of collection
         - Numbers, pounds, dates, locations, size (and coefficient of variation), and tag/mark information of released fish
         - Survival rates of all life stages (i.e., egg-to-smolt; smolt-to-adult)
         - Disease occurrence at hatcheries
         - Precocious maturation rates prior to release
         - Any problems that may have arisen during hatchery activities
         - Any unforeseen effects on listed fish
      ii) Natural Environmental Monitoring Report
         - The number of returning hatchery and natural-origin adults, including stray information to tributaries

- The number and species of listed fish encountered at each adult collection location, and the number that die
- The contribution of fish from these programs into ESA-listed populations (i.e., Methow River) based on coded wire tag recoveries/PIT tag detections
- Post-release out-of-basin migration timing (median travel time) of juvenile hatchery-origin fish to the confluence of the Snake River.
- Number and species of listed juveniles and adults encountered and the number that die during RM&E activities

Consistent with subparagraph 5(vi) of Limit 5 of the ESA 4(d) Rule, it is NMFS' intent to regularly communicate with the applicants regarding the HGMP's effects on listed salmon and steelhead population viability.

**Summary**

SFD has reviewed the HGMP provided by the applicants for the Wells summer Chinook salmon for SRKW hatchery program in the Upper Columbia River Basin (Table 1). Based on this review, SFD has determined that the plan addresses all of the requirements of Limit 5 of the 4(d) Rule. If the Regional Administrator concurs with this determination, take prohibitions for listed steelhead and salmon populations will not apply to activities implemented in accordance with the HGMP, provided that the program is operated in accordance with the implementation terms and reporting requirements described in NMFS' letter of concurrence.

**Concurrence**

I concur with your recommendation.

For

Barry A. Thom
Regional Administrator

May 15, 2020
Date

I do not concur with your recommended determination.

Barry A. Thom
Regional Administrator

Date

Attachment 1: ERD; Attachment 2: SEA; Attachment 3: FONSI; Attachment 4: Section 7 Biological Opinion

**Literature Cited**

NMFS. 2019a. Environmental Assessment for Endangered Species Act Section 4(d) Approval and Section 10(a)(1)(A) Permit Issuance for Steelhead Hatchery Programs and Section 10(a)(1)(B) Permits Issuance for Summer/Fall and Fall Chinook Salmon Hatchery Programs in Upper Columbia River Basin Final Environmental Assessment. June 2019. 134p.

NMFS. 2019b. Sufficiency Letter to Kelly Susewind (WDFW) and Shane Bickford (Douglas PUD) from Allyson Purcell (NMFS). Wells summer Chinook. December 3, 2019. 1p.

USFWS. 2020. Letter to Allyson Purcell (NMFS) from Brad Thompson (USFWS). Letter of Concurrence. March 31, 2020. 7p.

WDFW. 2019. Wells Hatchery Summer Chinook Program for Southern Resident Orca Recovery and Support HGMP. Upper Columbia River Summer Chinook (*Oncorhynchus tshawytscha*). WDFW, Olympia, Washington. October 9, 2019. 46p.

# Exhibit 4

# 4(d) Rule Limit 5

## Evaluation and Recommended Determination

| | |
|---|---|
| **Title:** | Hatchery and Genetic Management Plan for One Summer Chinook Salmon Hatchery Program in the Upper Columbia River Basin |
| **Submitted by:** | Washington Department of Fish and Wildlife<br>Douglas County Public Utilities District |
| **ESU/DPS:** | Upper Columbia River Spring Chinook<br>Upper Columbia River Steelhead<br>Southern Resident Killer Whales |
| **4(d) Rule Limit:** | ESA 4(d) Rule Limit 5 |
| **NMFS Tracking Number:** | WCR0-2020-00825 |
| **Date:** | May 8, 2020 |

# TABLE OF CONTENTS

# LIST OF TABLES

# 1 BACKGROUND

NOAA's National Marine Fisheries Service (NMFS) issued a final Endangered Species Act (ESA) 4(d) Rule adopting regulations (50 CFR 223.203) necessary and advisable to conserve salmonid species listed as threatened under the ESA (65 FR 42422, July 10, 2000; 70 FR 37160, June 28, 2005). The 4(d) Rule exempts the take of salmon and steelhead listed as threatened species under the ESA if the entity follows a Hatchery and Genetic Management Plan (HGMP) that meets the 4(d) Rule criteria and is approved by NMFS (July 10, 2000, 65 FR 42422, amended June 28, 2005, 70 FR 37160).

Under limit 5 of the 4(d) Rule—the limit that addresses hatchery programs described in HGMPs developed by state or federal agencies—ESA section 9 take prohibitions described in paragraph (a) of the 4(d) Rule (50 C.F.R. 223.203(a)) do not apply for species listed as threatened under the ESA to hatchery activities associated with artificial propagation programs provided that the elements of the 4(d) Rule are met, as discussed in section 3, below.

# 2 DESCRIBED HATCHERY PROGRAMS

The Washington Department of Fish and Wildlife (WDFW) and the Douglas County Public Utilities District (DPUD) have provided NMFS with one HGMP proposed for implementation in the Upper Columbia River region (Table 1). The applicants have provided the HGMP for review, determination, and approval by NMFS pursuant to 4(d) Rule limit 5. The HGMP specifies the release of one million additional subyearling summer Chinook salmon at the Wells Hatchery for this new program.

An application prepared by the co-managers (Table 1) was received and deemed sufficient by NMFS in 2019 (NMFS 2019). The activities included in this evaluation are described in HGMP (WDFW 2019).

**Table 1. Application details for the hatchery program.**

| Hatchery and Genetics Management Plan | Program Operator[1] | Program Funder[1] |
|---|---|---|
| Wells Summer Chinook for SRKW[1] | Washington Department of Fish and Wildlife and Douglas PUD[2] | Washington Department of Fish and Wildlife[3] and/or Pacific Salmon Treaty Funds |

[1]SRKW = Southern Resident Killer Whales
[2] Public Utility District No. 1 of Douglas County
[3]This will not include funding for Douglas PUD's normal operating and maintenance costs associated with their existing program obligations. Douglas PUD owns and operates Wells Hatchery.

Douglas PUD's existing production of summer Chinook includes 320,000 yearlings and 484,000 subyearling Chinook. These two programs are implemented under the terms and conditions of ESA Section 10(a)(1)(B) Permit No. 23193. The HGMP describes broodstock collection,

incubation, rearing, release, and monitoring and evaluation.

This increase in existing summer Chinook salmon production is proposed in support of the Washington State Southern Resident Orca Task Force recommendation to increase the abundance of Chinook salmon available in marine waters of Washington State. In May 2019, Washington State's Governor Jay Inslee signed into law a spending bill that included direct state funding to increase Chinook production.

NMFS worked with the applicants during the development of the HGMP to provide technical assistance, to exchange information, and to discuss what would be needed to conserve ESA-listed species. The biological opinion on the Wells summer Chinook hatchery program for Southern Resident Killer Whales concluded that the implementation of the program would not jeopardize the continued existence of ESA-listed salmon and steelhead, nor destroy or adversely modify designated critical habitat (). The following discussion evaluates whether the submitted plans address the criteria in section 223.203(b)(5) of the 4(d) rule for salmon and steelhead.

# 3 EVALUATION

Limit 5 of the 4(d) Rule for salmon and steelhead states that, for an HGMP to qualify for the limitation of take prohibitions, the following elements must be met:

## (5)(I) A STATE OR FEDERAL HATCHERY AND GENETICS MANAGEMENT PLAN (HGMP) HAS BEEN APPROVED BY NMFS AS MEETING THE FOLLOWING CRITERIA

National Marine Fisheries Service (NMFS) will approve an HGMP if it meets the specific criteria specified in 50 CFR 223.203(b)(5)(i). The following is an evaluation of whether the submitted HGMP meets these criteria.

## 3.1 5(i)(A) The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in meeting those results.

The HGMP has a clearly stated its goal, performance objectives, and methods for measuring the progress toward achieving those objectives. The general program goals described in Section 1.7 of each HGMP for propagating hatchery fish are to contribute to:

- Aiding in the recovery of Southern Resident Killer Whales
- Recovering ESA-listed upper Columbia River Chinook salmon and steelhead
- Providing for ceremonial and subsistence fishery values

Performance objectives and performance indicators that would be used to gauge compliance with each objective are described in Section 1.10 of the HGMP. Evaluation and monitoring to ensure standards and indicators are met are further described in Section 1.8 of this document and are summarized in Table 2.

Monitoring of HGMP implementation would generally be designed to determine:

1. Program consistency with proposed hatchery actions and intended results (e.g., juvenile fish release and adult return levels);
2. Measurement of the program's success or failure in attaining results; and
3. Effects of the program on listed natural-origin fish populations in the Upper Columbia River and its tributaries

**Table 2. Summary of typical HGMP program performance standards and indicators.**

| Standard | Indicator |
|---|---|
| Produce fish for harvest while minimizing excess hatchery returns | • Measure adult harvest and escapement<br>• Mass marking to allow selective fisheries |
| Supplement natural population (integrated programs only) | • Increasing proportion of natural-origin fish<br>• Increasing natural smolt levels |
| Proper broodstock collection and management | • Collected randomly throughout the run<br>• Weir/trap checked regularly<br>• Proportion of natural-origin fish<br>• Designated mating scheme, sex ratio<br>• Adheres to spawning guidelines (Seidel 1983)<br>• Stray rates |
| Meet hatchery juvenile production goal | • Egg to fry or smolt survival is as expected<br>• Release target |
| Minimize interactions of releases with natural-origin fish | • Juveniles released at sea-water ready life stages<br>• Size and time of release accounts for listed stocks |
| Life history characteristics of the natural population do not change due to artificial propogation | • Stable life history patterns of natural fish<br>• Age and size data for natural population |
| Natural population genetic variation does not change due to artificial propagation | • Proportion of naturally spawning hatchery fish<br>• Genetic assessment |
| Limit pathogen amplification and transmission | • Follows co-manager fish health policy described in the HGMP |

### 3.2 5(i)(B) The HGMP utilizes the concepts of viable and critical salmonid population thresholds, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations."

The HGMP proposed for consideration under the 4(d) Rule must use the concepts of viable and critical thresholds as defined in the NMFS Viable Salmonid Population (VSP) document (McElhany et al. 2000). Application of these VSP concepts is needed to adequately assess and limit the take of listed salmonids for the protection of the species. Section 2.2.2 of each HGMP describes the status of the listed Chinook salmon and steelhead populations relative to "critical" and "viable" population thresholds within the Columbia River and references NMFS reviews' of species status. In addition, the program described in Table 1 has been evaluated for its effects on the ESA-listed Chinook and steelhead listed in Table 3 .

**Table 3. Federal Register notices for the final rules that list species, designate critical habitat, or apply protective regulations to a listed species considered in this evaluation.**

| Species | Listing Status | Critical Habitat | Protective Regulations |
|---|---|---|---|
| **Chinook salmon *(Oncorhynchus tshawytscha)*** | | | |
| Upper Columbia River Spring | Endangered<br>70 FR 37160; [1]<br>June 28, 2005 | 70 FR 52630;<br>Sept 2, 2005 | ESA Section 9 |
| **Steelhead *(O. mykiss)*** | | | |
| Upper Columbia River | Threatened<br>74 FR 42605; August 24, 2009 | 70 FR 52630; Sept 2, 2005 | 70 FR 37160; June 28, 2005 |

### 3.3 5(i)(C) Taking into account health, abundances, and trends in the donor population, broodstock collection programs reflect appropriate priorities.

A prioritized purpose of a broodstock collection program using listed fish is to re-establish an indigenous salmonid population for conservation purposes, including restoration of similar at-risk populations within the same ESU, and reintroduction of at-risk populations to under-seeded habitat. Under this 4(d) Rule criterion, as described in the 4(d) Rule, listed salmonids may be intentionally taken for broodstock only if:

1. The donor population is currently at or above the viable threshold and the collection will not impair its function, or
2. The donor population is not currently viable but the sole objective is to enhance the propagation or survival of the listed ESU, or
3. The donor population is shown with a high degree of confidence to be above the critical threshold although not yet functioning at viable levels, and the collection will not appreciably slow attainment of viable status for that population.

The program is segregated, meaning it does not incorporate natural-origin fish into their broodstock.

### 3.4 5(i)(D) The HGMP includes protocols to address fish health, broodstock collection and spawning, rearing and release of juveniles, disposition of hatchery adults, and catastrophic risk management.

The proposed HGMP includes protocols, or “best management practices” (BMPs), for fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management. These practices, when implemented, would be appropriate for the purpose of adequately limiting the risk of substantial direct and incidental adverse effects on listed fish in the Upper Columbia River.

*Fish Health (HGMP sections 7, 9, and 10 of HGMP):* The hatchery program would be operated in compliance with co-manager and state fish health policies. The policies are designed to limit the spread of fish pathogens between and within watersheds by regulating the transfers of eggs and fish. The policies also outline standard fish health diagnosis, maintenance, and hatchery sanitation protocols to reduce the risk of pathogen amplification and transmission within the hatchery and to fish in the natural environment during broodstock collection and mating as well as fish incubation, rearing, and release. Fish health specialists and pathologists from WDFW would provide fish health management support and diagnostic fish health services.

*Broodstock Collection and Spawning (HGMP sections 6, 7 and 8):* This program is segregated and does not use natural-origin fish in broodstock. To minimize the risk of artificial trait selection, returning hatchery fish used in broodstock are collected over the course of the run. The BMPs for broodstock spawning are described in section 8 of the HGMP. The protocols for broodstock implement spawning actions are consistent with published guidelines (HSRG 2004; Seidel 1983). Spawnings are conducted pairwise (1x1). Broodstock collection and spawning

details are summarized in Table 4.

**Table 4. Annual number of broodstock collected, collection method, and spawning approach.**

| Broodstock collection | | | | | |
|---|---|---|---|---|---|
| **Program Type and Purpose** | **Number and origin** | **Method and location(s)** | **Approximate timing and frequency[1]** | **NMFS PNI or pHOS targets and pNOB[2]** | **Spawning site and mating protocol** |
| Segregated harvest | 756[3] adults; hatchery-origin | Wells Hatchery; Wells Dam | July 1-Aug 28; 24 hr/day, up to 7 days/week at hatchery; 16 hr/day, 3 days/week at dam | N/A | On-station; 1:1 sex ratio |

[1]Start date of broodstock collection may be earlier than July 1 to accommodate earlier arrival timing of the run, but operators will contact NMFS if this occurs.
[2]PNI = Proportionate Natural Influence [pNOB/(pNOB+pHOS)]; pHOS = proportion of hatchery-origin fish on the spawning grounds; pNOB = proportion of natural-origin fish in broodstock
[3]Values based on a current, mean fecundity of 4,171 (H) and 4,662 (W), an egg-to-smolt survival of 0.805, a 1:1 male:female ratio, and 97.9% pre-spawn adult survival. Broodstock numbers reflect a ~ 99% chance of meeting the program production targets.

*Rearing and Release of Juveniles (HGMP sections 9 and 10):* Releases will not be in locations other than those being proposed. All summer Chinook salmon receive an adipose clip, and a portion of the release receives a tag prior to release to allow for their differentiation from natural-origin salmon. In addition, all fish would be released at times consistent with requirements set forth in the Wells biological opinion (NMFS 2020) to limit interactions (e.g., competition and predation) with emigrating ESA-listed natural-origin fish. Fish health staff monitor the fish throughout their rearing cycle for signs of disease. Mortalities are checked daily and live grab samples are taken monthly. Fish are also tested before release. Sampling, testing, and treatment/control procedures are outlined in and consistent with IHOT (1995); NWIFC and WDFW (2006); PNFHPC (1989). Release numbers, life stage, mark/tag types, and dates for all hatchery programs are detailed in Table 5.

**Table 5. Summary of annual release groups (number and life stage), egg incubation location, rearing location, acclimation site and time, and release time and location for the program CWT stands for Coded-Wire Tagged.**

| Annual release groups (number and life stage) | Marking and Tagging | Egg incubation Location | Rearing Location | Acclimation Site and Time | Release Time and Location |
|---|---|---|---|---|---|
| 1.0 million subyearlings[1] | 100% adipose-clipped and >=32% CWT[2] | Wells Hatchery | | Wells Hatchery; October to May[3] | May[4]; Columbia River (RM 515) |

[1]The 1.0M is an "up-to" value depending on funding. Presently, the first two years of production is funded at the 500K production level annually.
[2] Approximately 484,000 fish will be marked with CWT of the total Chinook subyearling production at Wells Hatchery including the SRKW Summer Chinook program.

[3]The acclimation timing for this program also includes timeframes for juvenile rearing because juvenile rearing and acclimation take place in the same facility.
[4]Volitional release occurs in mid-May.

*Disposition of Hatchery Adults (Section 7.5 of the HGMP):* In general, spawned hatchery carcasses are either used to support nutrient enhancement programs in the Upper Columbia River, given to the Tribes for subsistence or ceremonial use, given to food banks, sold to rendering companies, or used for other hatchery programs as determined by the respective committees or co-managers. Fish treated for pathogens or otherwise unfit for human consumption are buried in approved land-fills.

*Catastrophic Risk Management (Section 5.8 of the HGMP):* The hatchery program adheres to the applicants' fish health policies (NWIFC and WDFW 2006; USFWS 2004) and apply BMPs to reduce the risk of catastrophic loss of fish under propagation. Furthermore, the hatchery has staff on site and low-water alarms.

### 3.5 5(i)(E) The HGMP evaluates, minimizes, and accounts for the propagation programs' genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by straying of hatchery fish.

The HGMP provides evaluations of potential genetic and ecological effects on listed salmon and steelhead in section 2 and risk minimization measures in sections 6 through 10.

*Genetic effects:* Artificial fish production may result in a loss of within-population genetic diversity (the reduction in quantity, variety and combinations of alleles in a population), outbreeding depression (loss in fitness caused by changes in allele frequency or the introduction of new alleles) and/or hatchery-influenced selection.

The HGMP accounts for and minimizes genetic risks to ESA-listed salmon and steelhead populations through implementation of the following measures for this segregated program:

- Straying is monitored to assess spawning proportions of hatchery- and natural-origin salmon and steelhead
- Juveniles are acclimated at their site of release to decrease straying potential

*Ecological effects:* The primary ecological risks to natural-origin salmon and steelhead populations posed by salmon and steelhead hatchery programs are increased pathogen transfer, competition, and predation. As noted in the HGMP and earlier in this document, all hatchery actions would be implemented in accordance with the co-manager fish health policies as a means to account for and minimize the risks of pathogen amplification and transmission.

The HGMP accounts for and minimizes ecological risks to listed salmon and steelhead populations through implementation of the following measures:

- Juveniles are acclimated at their site of release to decrease straying potential
- Monitoring of residuals (PIT tag arrays and//or visual inspections prior to release)

**3.6 5(i)(F) The HGMP describes interrelationships and interdependencies with fisheries management.**

Descriptions of this criterion occur in section 3 of the HGMP. As described in the HGMP, state recreational and tribal fisheries for hatchery-origin species produced independently from the program may incidentally affect ESA-listed natural-origin Chinook and steelhead. However, these fisheries are not considered interrelated with or interdependent on these programs because the main goal of the program is to produce Chinook salmon for Southern Resident Killer Whales. It is also important to note that, even if program fish are encountered during fisheries, this program is not the sole producers of fish for the fisheries.

**3.7 5(i)(G) Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, to maintain population health and diversity, and to avoid hatchery-influenced selection and domestication.**

As described in sections 4 and 5 of the HGMP, the hatchery facilities used to implement the programs have adequate surface and groundwater sources, fish trapping and holding facilities, egg incubation and fish rearing vessels, and fish release facilities to ensure proper rearing. Facilities that rear over 20,000 pounds of fish operate under applicable National Pollutant Discharge Elimination System (NPDES) general permits, which provide for monitoring of temperature, chlorine, and settleable and suspended solids in facility effluent. As mentioned previously, fish health is maintained throughout rearing by adhering to fish health policies and using pathogen-free water sources when possible (HGMP sections 7, 9 and 10). Minimization of catastrophic loss and genetic risks associated with these programs were addressed in sections 3.4 and 3.5, respectively, of this document.

**3.8 5(i)(H) Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of the listed ESU.**

Monitoring and evaluation actions to identify the performance of the program and hatchery-related effects on ESA-listed fish are proposed and are already covered under previous NMFS permits and authorizations (NMFS 2016; NMFS 2017a; NMFS 2017b). These actions are summarized in section 1.10 of the HGMP and further described in section 11 of the HGMP. Monitoring and evaluation actions that are already being implemented include:

- Spawning ground/redd surveys and hatchery escapement to determine total escapement and percent of hatchery-origin spawners spawning naturally (possible for marked fish only)
- The number and distribution of marked, unmarked, and otolith-marked fish to determine the status of the natural- and hatchery-origin salmon returns and harvest relative to goal levels

- Abundance, timing, age class, sex ratio, and fish health condition data collected for broodstock to assess run traits of the target populations
- Water withdrawal and effluent discharge to ensure compliance with permitted levels
- Monitoring of broodstock collection, egg take, fish survival rates, and smolt release levels for each program to determine compliance with program goals
- Fish health monitoring and reporting in compliance with fish health policies

### 3.9 5(i)(I) The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed.

Under section 1.10 of the HGMP, data collected relating to hatchery program performance and effects would be evaluated by the WDFW and DPUD to determine whether performance standards were met. Annual reports for the program assembled by the applicants would be jointly reviewed by NMFS to document program results, and to determine if adjustments to the programs assumptions and management strategies are warranted. Any changes would be incorporated into Annual Operating Plan documents, the HGMP as necessary, and/or annual Future Brood Documents produced by the co-managers and Hatchery Action Implementation Plans produced by local watersheds.

### 3.10 5(i)(J) NMFS provides written concurrence [with] the HGMP, which specifies the implementation and reporting requirements.

Written concurrence with an HGMP is a requirement specific to Limit 5 of the 4(d) Rule. With the current document, as well as after consulting with itself under section 7 of the ESA, NMFS has documented its recommended determination for this HGMP. NMFS will notify the WDFW and DPUD of our determination, final decision, and any implementation and reporting requirements specified herein [50 CFR 223.203(b)(5)(i)(J)].

### 3.11 5(i)(K) The HGMP is consistent with plans and conditions set within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

The HGMP is one component of an effort to preserve and recover to a fishable status listed salmon and steelhead in the Columbia River Basin and Southern Resident Killer Whales. The final recovery plans for ESA listed Columbia River Basin salmonids and Southern Resident Killer Whales have salmon hatchery and habitat components, and include monitoring, research, and restoration recommendations to complement artificial production. The hatchery actions proposed in the HGMP is included within, and consistent with, these recovery plans. There are no other plans or conditions set within Federal court proceedings—including memorandums of understanding, court orders, or other management plans—that direct operation of the proposed salmon and steelhead hatchery programs.

## 4 PUBLIC REVIEW AND COMMENTS

As required in (5)(iv) of section 223.203 of the 4(d) rule for salmon and steelhead, the Secretary published notice of the availability of the plans for public review and comment. The HGMP was made available for a 30-day public comment period upon notice of availability in the Federal Register on January 7, 2020 (85 FR 704). We received comments from one commenter. The commenter offered suggestions for improving the HGMP, but the comments did not address the consistency of the HGMP with 4(d) Rule limit 5 criteria. None of the comments resulted in edits to the HGMP.

## 5 RECOMMENDED DETERMINATION

NMFS has reviewed the HGMP described above, and evaluated it against the requirements of Limit 5 of the 4(d) rule for salmon and steelhead. Based on this review and evaluation, including consideration of public comments and the associated biological opinion (NMFS 2020), NMFS' recommended determination is that activities implemented, as described in the HGMP, would not appreciably reduce the likelihood of survival and recovery of ESA-listed salmon or steelhead ESU/DPSs in the Columbia River. If the Regional Administrator concurs with this determination, take prohibitions described for ESA-listed salmon and steelhead in the Columbia River basin would not apply to activities implemented in accordance with the HGMP listed in Table 1.

## 6 REEVALUATION CRITERIA

NMFS will reevaluate this determination in accordance with 50 CFR 223.203(b)(5)(vi). Factors for judging the effectiveness of each HGMP in protecting and achieving a level of salmonid productivity commensurate with the conservation of the listed salmonids may include, but are not limited to, whether: (1) the actions described by the HGMP are modified in a way that causes an effect on the listed species that was not previously considered in NMFS' evaluation; (2) new information or monitoring reveals effects that may affect listed species in a way not previously considered; or (3) a new species is listed or critical habitat is designated that may affect NMFS' evaluation of the HGMP.

## 7 REFERENCES

HSRG. 2004. Hatchery reform: Principles and Recommendations of the Hatchery Scientific Review Group. April 2004. Available at Long Live the Kings. 329p.

IHOT. 1995. Policies and procedures for Columbia basin anadromous salmonid hatcheries. Annual report 1994 to Bonneville Power Administration, project No. 199204300, (BPA Report DOE/BP-60629). Bonneville Power Administration.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42. 174p.

NMFS. 2016. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Issuance of Four Section 10(a)(1)(A) Permits for Spring Chinook Salmon Hatchery Programs in the Methow Subbasin. October 13, 2016. NMFS Consultation No.: WCR-2015-3845. 116p.

NMFS. 2017a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Four Summer/Fall Chinook Salmon and Two Fall Chinook Salmon Hatchery Programs in the Upper Columbia River Basin. December 26, 2017. NMFS Consultation No.: WCR-2015-3607. 186p.

NMFS. 2017b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Two Steelhead Hatchery Programs in the Methow River. October 10, 2017. NMFS Consultation No.: WCR-2017-6986. 117p.

NMFS. 2019. Sufficiency Letter to Kelly Susewind (WDFW) and Shane Bickford (Douglas PUD) from Allyson Purcell (NMFS). Wells summer Chinook. December 3, 2019. 1p.

NMFS. 2020. Wells Summer Chinook Hatchery Program for SRKW Biological Opinion.

NWIFC, and WDFW. 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Revised July 2006. 38p.

PNFHPC. 1989. Model Comprehensive Fish Health Protection Program. Approved September 1989, revised February 2007. PNFHPC, Olympia, Washington. 22p.

Seidel, P. 1983. Spawning Guidelines for Washington Department of Fisheries Hatcheries. 18p.

WDFW. 2019. Wells Hatchery Summer Chinook Program for Southern Resident Orca Recovery and Support HGMP. Upper Columbia River Summer Chinook (*Oncorhynchus tshawytscha*). WDFW, Olympia, Washington. October 9, 2019. 46p.

# Exhibit 5

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

May 15, 2020

Kelly Susewind, Director
Washington Department of Fish and Wildlife
600 Capital Way N
Olympia, Washington 98501

Shane Bickford, Director Natural Resources
Douglas County Public Utility District
1151 Valley Mall Parkway
East Wenatchee, WA 98802

Dear Mr. Susewind and Mr. Bickford:

NOAA's National Marine Fisheries Service (NMFS) has evaluated the Hatchery Genetic and Management Plan (HGMP) for the summer Chinook salmon hatchery program for Southern Resident Killer Whales in the Upper Columbia River Basin (listed in Table 1 of the associated Biological Opinion) for their effects on salmon and steelhead listed under the Endangered Species Act (ESA). NMFS concludes that the HGMP meets the requirements of Limit 5 of the 4(d) Rules for salmon and steelhead, 50 CFR 223.203(b)(5). Take of threatened salmon and steelhead resulting from activities undertaken pursuant to the HGMP is not prohibited under the ESA, provided activities are implemented by the co-managers in accordance with the implementation terms and reporting requirements in the associated Biological Opinion and summarized below. The co-managers shall:

1) Provide advance notice of any change in program operation and implementation that may increase the amount or extent of take, or results in an effect of take not previously considered.
2) Notify NMFS Sustainable Fishery Division (SFD) within 48 hours after knowledge of exceeding authorized take. The applicants shall submit a written report, and/or convene a discussion with NMFS to discuss why the authorized take was exceeded.
3) The applicants implement the Wells Summer Chinook Hatchery Program for Southern Resident Killer Whales program as described in the Proposed Action (Section 1.2) and the submitted HGMP including:
   a) Providing advance notice to NMFS of any change in hatchery program operation that potentially increases the amount or extent of take, or results in an effect of take not previously considered.
   b) Providing notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion.
   c) Allowing NMFS to accompany any employee or representative field personnel while they conduct activities covered by their biological opinion.

4) The applicants provide reports to NMFS SFD annually on December 31st a year after collection of data for the hatchery program and associated research, monitoring, and evaluation (RM&E).
   a) All reports/notifications be submitted electronically to the NMFS SFD point of contact for this opinion: Natasha Preston (503) 231-2178, natasha.preston@noaa.gov.
   b) Applicants will notify NMFS SFD within 48 hours after exceeding any authorized take, and shall submit a written report detailing why the authorized take was exceeded within two weeks of the event.
   c) Annual reports to SFD for hatchery programs should include:
      i) The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities Hatchery Environment Monitoring Report
         - Number and composition of broodstock, and dates of collection
         - Numbers, pounds, dates, locations, size (and coefficient of variation), and tag/mark information of released fish
         - Survival rates of all life stages (i.e., egg-to-smolt; smolt-to-adult)
         - Disease occurrence at hatcheries
         - Precocious maturation rates prior to release
         - Any problems that may have arisen during hatchery activities
         - Any unforeseen effects on listed fish
      ii) Natural Environmental Monitoring Report
         - The number of returning hatchery and natural-origin adults, including stray information to tributaries
         - The number and species of listed fish encountered at each adult collection location, and the number that die
         - The contribution of fish from these programs into ESA-listed populations (i.e., Methow River) based on coded wire tag recoveries/PIT tag detections
         - Post-release out-of-basin migration timing (median travel time) of juvenile hatchery-origin fish to the confluence of the Snake River.
         - Number and species of listed juveniles and adults encountered and the number that die during RM&E activities

Thank you for the time your staff has invested in developing the HGMP and assisting with providing information throughout the consultation and associated Supplemental Environmental Assessment. NMFS looks forward to working with you on the implementation of these programs. Please contact Natasha Preston, Fisheries Biologist, of my staff with any questions, at (503) 231-2178, natasha.preston@noaa.gov.

Sincerely,

for Barry A. Thom
Regional Administrator

CC: Eric Kinne, WDFW
Michael Tonseth, WDFW
Chad Jackson, WDFW
Greg Mackey, Douglas PUD
Tom Kahler, Douglas PUD

# Exhibit 6

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

Wells Summer Chinook Hatchery Program for Southern Resident Killer Whales

NMFS Consultation Number: WCR0-2020-00825

Action Agencies: National Marine Fisheries Service (NMFS)

Program Operators: Douglas Public Utility District and Washington Department of Fish and Wildlife

Affected Species and Determinations:

| **ESA-Listed Species** | **Status** | **Is the Action Likely to Adversely Affect Species or Critical Habitat?** | **Is the Action Likely To Jeopardize the Species?** | **Is the Action Likely To Destroy or Adversely Modify Critical Habitat?** |
|---|---|---|---|---|
| Upper Columbia River steelhead (*Oncorhynchus mykiss*) | Threatened | Yes | No | No |
| Upper Columbia River Spring Chinook salmon *(Oncorhynchus tshawytscha)* | Endangered | Yes | No | No |
| Southern Resident Killer Whales | Endangered | No | No | No |

| **Fishery Management Plan That Describes EFH in the Project Area** | **Does the Action Have an Adverse Effect on EFH?** | **Are EFH Conservation Recommendations Provided?** |
|---|---|---|
| Pacific Coast Salmon | No | No |

Consultation Conducted By: National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division

Issued By:

Ryan J. Wulff
Assistant Regional Administrator
Sustainable Fisheries Division

Date: 05/11/2020

This page intentionally left blank.

## TABLE OF CONTENTS

## List of Tables

# 1. INTRODUCTION

Pursuant to section 4(d) of the Endangered Species Act and associated regulations at 50 CFR 223.203(b)(6), the National Marine Fisheries Service (NMFS) is reviewing a salmonid hatchery program to determine whether the program meets the regulatory requirements, including a finding that they will not appreciably reduce the likelihood of survival and recovery of threatened salmon or steelhead. If NMFS finds that the requirements are met, the prohibitions of ESA §9 will not apply to the take by the hatchery program of threatened salmonids.

NMFS describes a hatchery program as a group of fish that have a separate purpose and that may have independent spawning, rearing, marking, and release strategies (NMFS 2008a). The operation and management of every hatchery program is unique in time, and specific to an identifiable stock and its native habitat (Flagg et al. 2004)).

The underlying activities that drive the Proposed Action are the operation and maintenance of one hatchery program rearing and releasing in the Upper Columbia River. The hatchery program is operated by Douglas PUD under contract to WDFW as described in Table 1. The program is described in detail in the Hatchery and Genetic Management Plan (HGMP) (and accompanying supplementary material), which was submitted to NMFS for review.

**Table 1. Hatchery program included in the Proposed Action and ESA coverage pathway requested.**

| Program | HGMP Receipt | Program Operator | Funding Agencies | Program Type and Purpose | ESA Pathway |
|---|---|---|---|---|---|
| Wells Summer Chinook for SRKW[1] | October 9, 2019 | Washington Department of Fish and Wildlife and Douglas PUD[2] | Washington Department of Fish and Wildlife[3] and/or Pacific Salmon Treaty Funds | Segregated Harvest for SRKW recovery and sustainability | 4(d) Limit 5 |

[1]SRKW = Southern Resident Killer Whales
[2] Public Utility District No. 1 of Douglas County
[3]This will not include funding for Douglas PUD's normal operating and maintenance costs associated with their existing program obligations. Douglas PUD owns and operates Wells Hatchery.

NMFS prepared the Biological Opinion (Opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402. The opinion documents consultation on the actions proposed by NMFS.

NMFS also completed an Essential Fish Habitat (EFH) consultation on the Proposed Action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq*.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System. A complete record of this consultation is on file at the Sustainable Fisheries Division (SFD) of NMFS in Portland, Oregon.

### 1.1. Consultation History

The first hatchery consultations in the Columbia Basin followed the first listings of Columbia Basin salmon under the Endangered Species Act (ESA). Snake River sockeye salmon were listed as an endangered species on November 20, 1991, Snake River spring/summer Chinook salmon and Snake River fall Chinook salmon were listed as threatened species on April 22, 1992, and the first hatchery consultation and opinion was completed on April 7, 1994 (NMFS 1994). The 1994 opinion was superseded by "Endangered Species Act Section 7 Biological Opinion on 1995-1998 Hatchery Operations in the Columbia River Basin, Consultation Number 383" completed on April 5, 1995 (NMFS 1995b). This opinion determined that hatchery actions jeopardize listed Snake River salmon and required implementation of reasonable and prudent alternatives (RPAs) to avoid jeopardy.

A new opinion was completed on March 29, 1999, after Upper Columbia River (UCR) steelhead were listed under the ESA (62 FR 43937, August 18, 1997) and following the expiration of the previous opinion on December 31, 1998 (NMFS 1999). That opinion concluded that Federal and non-Federal hatchery programs jeopardize Lower Columbia River (LCR) steelhead and Snake River steelhead protected under the ESA and described RPAs necessary to avoid jeopardy. Those measures and conditions included restricting the use of non-endemic steelhead for hatchery broodstock and limiting stray rates of non-endemic salmon and steelhead to less than 5% of the annual natural population in the receiving stream. Soon after, NMFS reinitiated consultation when LCR Chinook salmon, UCR spring Chinook salmon, Upper Willamette Chinook salmon, Upper Willamette steelhead, Columbia River chum salmon, and Middle Columbia steelhead were added to the list of endangered and threatened species (Smith 1999).

Between 1991 and the summer of 1999, the number of distinct groups of Columbia Basin salmon and steelhead listed under the ESA increased from 3 to 12, and this prompted NMFS to reassess its approach to hatchery consultations. In July 1999, NMFS announced that it intended to conduct five consultations and issue five opinions “instead of writing one biological opinion on all hatchery programs in the Columbia River Basin” (Smith 1999). Opinions would be issued for hatchery programs in the (1) Upper Willamette, (2) Middle Columbia River (MCR), (3) LCR, (4) Snake River, and (5) UCR, with the UCR NMFS’ first priority (Smith 1999). Between August 2002 and October 2003, NMFS completed consultations under the ESA for approximately twenty hatchery programs in the UCR. For the MCR, NMFS completed a draft opinion, and distributed it to hatchery operators and to funding agencies for review on January 4, 2001, but completion of consultation was put on hold pending several important basin-wide review and planning processes.

The increase in ESA listings during the mid to late 1990s triggered a period of investigation, planning, and reporting across multiple jurisdictions and this served to complicate, at least from a resources and scheduling standpoint, hatchery consultations. A review of Federal funded hatchery programs ordered by Congress was underway at about the same time that the 2000 Federal Columbia River Power System (FCRPS) opinion was issued by NMFS (NMFS 2000a). The Northwest Power and Conservation Council (Council) was asked to develop a set of coordinated policies to guide the future use of artificial propagation, and RPA 169 of the FCRPS opinion called for the completion of NMFS-approved hatchery operating plans (i.e., HGMPs) by the end of 2003. The RPA required the Action Agencies to facilitate this process, first by assisting in the development of HGMPs, and then by helping to implement identified hatchery reforms. Also at this time, a new *U.S. v. Oregon* Columbia River Fisheries Management Plan (CRFMP), which included goals for hatchery management, was under negotiation and new information and science on the status and recovery goals for salmon and steelhead was emerging from Technical Recovery Teams (TRTs). Work on HGMPs under the FCRPS opinion was undertaken in cooperation with the Council’s Artificial Production Review and Evaluation process, with CRFMP negotiations, and with ESA recovery planning (Foster 2004; Jones Jr. 2002). HGMPs were submitted to NMFS under RPA 169; however, many were incomplete and, therefore, were not found to be sufficient for ESA consultation.

ESA consultations and an opinion were completed in 2007 for nine hatchery programs that produce a substantial proportion of the total number of salmon and steelhead released into the

Columbia River annually. These programs are located in the LCR and MCR and are operated by the USFWS and by the Washington Department of Fish and Wildlife (WDFW). NMFS' opinion (NMFS 2007) determined that operation of the programs would not jeopardize salmon and steelhead protected under the ESA.

On May 5, 2008, NMFS published a Supplemental Comprehensive Analysis (SCA) (NMFS 2008f) and an opinion and RPAs for the FCRPS to avoid jeopardizing ESA-listed salmon and steelhead in the Columbia Basin (NMFS 2008c). The SCA environmental baseline included "the past effects of hatchery operations in the Columbia River Basin. Where hatchery consultations have expired or where hatchery operations have yet to undergo ESA section 7 consultation, the effects of future operations cannot be included in the baseline. In some instances, effects are ongoing (e.g., returning adults from past hatchery practices) and included in this analysis despite the fact that future operations cannot be included in the baseline. The Proposed Action does not encompass hatchery operations per se, and therefore no incidental take coverage is offered through this biological opinion to hatcheries operating in the region. Instead, we expect the operators of each hatchery to address its obligations under the ESA in separate consultations, as required" (see NMFS 2008f, p. 5-40).

Because it was aware of the scope and complexity of ESA consultations facing the co-managers and hatchery operators, NMFS offered substantial advice and guidance to help with the consultations. In September 2008, NMFS announced its intent to conduct a series of ESA consultations and that "from a scientific perspective, it is advisable to review all hatchery programs (i.e., Federal and non-Federal) in the UCR affecting ESA-listed salmon and steelhead concurrently" (Walton 2008). In November 2008, NMFS expressed again, the need for re-evaluation of UCR hatchery programs and provided a "framework for ensuring that these hatchery programs are in compliance with the Federal Endangered Species Act" (Jones Jr. 2008). NMFS also "promised to share key considerations in analyzing HGMPs" and provided those materials to interested parties in February 2009 (Jones Jr. 2009).

On April 28, 2010 (Walton 2010), NMFS issued a letter to "co-managers, hatchery operators, and hatchery funding agencies" that described how NMFS "has been working with co-managers throughout the Northwest on the development and submittal of fishery and hatchery plans in compliance with the Federal ESA." NMFS stated, "In order to facilitate the evaluation of hatchery and fishery plans, we want to clarify the process, including consistency with *U.S. v. Oregon*, habitat conservation plans and other agreements…." With respect to "Development of Hatchery and Harvest Plans for Submittal under the ESA," NMFS clarified: "The development of fishery and hatchery plans for review under the ESA should consider existing agreements and be based on best available science; any applicable multiparty agreements should be considered, and the submittal package should explicitly reference how such agreements were considered. In the Columbia River, for example, the *U.S. v. Oregon* agreement is the starting place for developing hatchery and harvest plans for ESA review…."

The HGMP was submitted for formal review as described in Table 1. This consultation evaluates the effects of the proposed hatchery program on one salmon ESU and one steelhead DPS in the Upper Columbia River Basin under the ESA, and their designated critical habitat. It also evaluates the effects of the program on Essential Fish Habitat (EFH) under the MSA.

Other summer Chinook programs are reared at Wells Hatchery and have been analyzed in a previous biological opinion (NMFS 2017b) and accompanying section 10(a)(1)(B) permits.

### 1.2. Proposed Federal Action

"Action," as applied under the ESA, means all activities, of any kind, authorized, funded, or carried out, in whole or in part, by Federal agencies. For EFH consultation, "Federal action" means any on-going or Proposed Action authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). Because the actions of the Federal agencies are subsumed within the effects of the hatchery program, and any associated research, monitoring and evaluation, the details of each hatchery program are summarized in this section. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

The objective of this opinion is to determine the likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from operation of the proposed hatchery program in the Upper Columbia River. The applicants propose to wholly carry out all activities described in the Wells Summer Chinook for Southern Resident Killer Whales (SRKW) HGMP (WDFW 2019).

There is one federal Proposed Action we are considering in this opinion:

- The Proposed Action for National Marine Fisheries Service (NMFS) is the approval of the Columbia River summer Chinook salmon hatchery program (Table 1) HGMP under 4(d) of the Endangered Species Act (ESA).

The objective of this opinion is to determine the likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from this Federal action. The effects of this action, as well as the WDFWs' funding of the program, is subsumed within the operation of the hatchery program. Therefore, this Opinion will determine if the actions proposed by the operators comply with the provisions of sections 7 and 10(a)(1)(B) of the ESA. The duration of the Proposed Action is unlimited from the date of Opinion completion.

The proposed hatchery program produces subyearling summer Chinook salmon with the primary intent for Southern Resident Orca recovery and sustainability. The approval of this HGMP would authorize take of listed species incidental to the implementation of the proposed summer Chinook salmon artificial propagation program in the UCR region. Below is a description of the proposed activities.

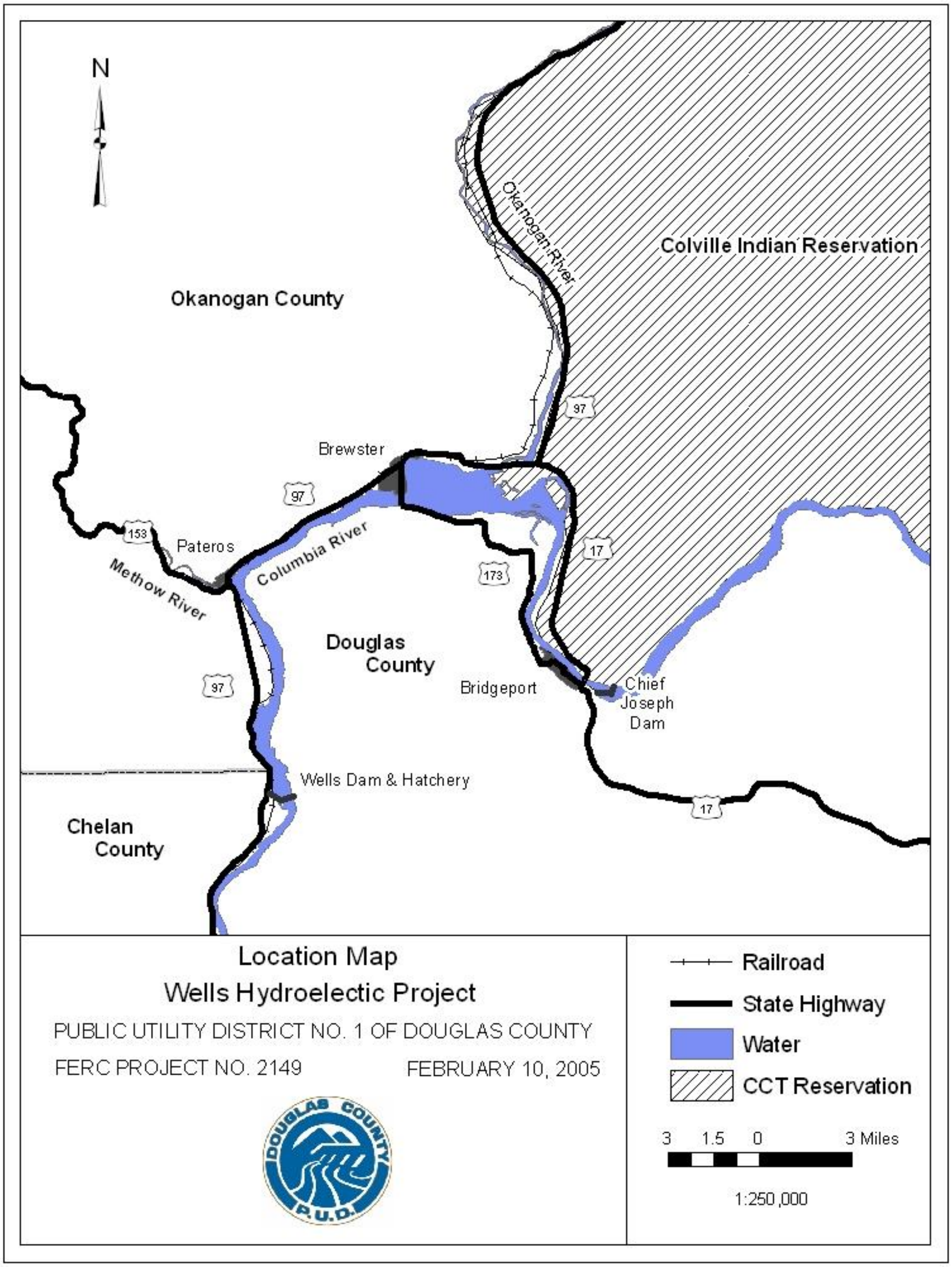


Figure 1. Map of Wells Dam and Hatchery in the Upper Columbia River Basin in the Proposed Action (Courtesy of Shane Bickford, DPUD

### 1.2.1. Program Purpose and Type

The purpose of the new segregated Wells Summer Chinook artificial propagation program is to provide increased numbers of summer Chinook for Southern Resident Killer Whales (SRKW) recovery and sustainability.

### 1.2.2. Proposed Hatchery Broodstock Collection Details

Broodstock collection facilities consist of the Wells Hatchery volunteer channel and the Wells Dam east and west fish ladder traps, if needed. The volunteer channel is the primary source for Wells Hatchery SRKW summer Chinook broodstock.

Douglas PUD and WDFW will annually develop broodstock collection protocols for this program. These objectives and protocols may be adjusted in season to meet changes in the abundance, composition, and location of adult returns, and to minimize impacts on non-target ESA listed Upper Columbia River (UCR) endangered spring Chinook salmon and threatened UCR steelhead..

For the proposed program, broodstock would be collected throughout the run to ensure that the range of traits associated with return timing are represented to reduce the potential for inadvertent genetic selection. Traps would be checked daily when in operation and incidentally captured, endangered UCR spring Chinook salmon and threatened UCR steelhead would be removed. Operators would monitor the incidence of, and minimize capture, holding, and handling effects on, listed salmon, steelhead, and bull trout. All incidentally captured listed fish would be handled via water-to-water transfer, if possible, and immediately released upstream of the trap. If water temperature at adult traps during trapping or during implementation of live capture methods exceeded 21°C, trap operation and live capture would cease pending further consultation with NMFS to determine if continued trap operation and live capture would pose substantial risk to ESA-listed species or until temperatures fell below 21°C.

Please refer to Table 2 for additional information regarding broodstock collection and management for this program.

**Table 2. Broodstock collection and spawning details. NOR stands for Natural-Origin Return and HOR stands for Hatchery-Origin Return**

| Program | Broodstock collection | | | | | | |
|---|---|---|---|---|---|---|---|
| | Program Type and Purpose | ESA listed population of fish used in broodstock[1] | Number and origin | Method and location(s) | Approximate timing and frequency[2] | NMFS PNI or pHOS targets and pNOB[3] | Spawning site and mating protocol |
| **Wells Summer Chinook for SRKW** | Segregated harvest | N/A | 756[4] adults; hatchery-origin | Wells Hatchery; Wells Dam | July 1-Aug 28; 24 hr/day, up to 7 days/week at hatchery; 16 hr/day, 3 days/week at dam | N/A | On-station; 1:1 sex ratio |

[1]No ESA listed fish are used in broodstock

[2]Start date of broodstock collection may be earlier than July 1 to accommodate earlier arrival timing of the run, but operators will contact NMFS if this occurs.
[3]PNI = Proportionate Natural Influence [pNOB/(pNOB+pHOS)]; pHOS = proportion of hatchery-origin fish on the spawning grounds; pNOB = proportion of natural-origin fish in broodstock
[4]Values based on a current, mean fecundity of 4,171 (H) and 4,662 (W), an egg-to-smolt survival of 0.805, a 1:1 male:female ratio, and 97.9% pre-spawn adult survival. Broodstock numbers reflect a ~ 99% chance of meeting the program production targets.

### 1.2.3. **Proposed Hatchery Egg Incubation and Juvenile Rearing, Acclimation, and Release**

Please refer to Table 3 for information regarding annual release groups, marking/tagging, egg incubation location, rearing location, acclimation site and time, and release time and location for the program.

In addition, there is a 10% overage buffer of juvenile releases, whereby in a single year the operator may release up to an additional 10%. This accounts for occasional increases in fecundity and/or hatchery survival, which are balanced against the years in which the total number of smolts released is below the limit. Releases should not be in locations other than those proposed and the number released, by life-stage, should not exceed 110% of the proposed production levels in any individual year. Additionally, the releases should not exceed 105% across a five-year running average. This additional production buffer should be used in the minority of situations and annual operational adjustments, to maintain consistency with the proposed production levels and life stages, should be addressed during the development of the annual operation plan(s). NMFS expects the releases to be at or below 100% in any given year but our conclusions in this opinion include these potential exceedances.

**Table 3. Summary of annual release groups (number and life stage), egg incubation location, rearing location, acclimation site and time, and release time and location for the program CWT stands for Coded-Wire Tagged.**

| Program | Annual release groups (number and life stage) | Marking and Tagging | Egg incubation Location | Rearing Location | Acclimation Site and Time | Release Time and Location |
|---|---|---|---|---|---|---|
| **Wells Summer Chinook for SRKW** | 1.0 million subyearlings[1] | 100% adipose-clipped and >=32% CWT[2] | Wells Hatchery | | Wells Hatchery; October to May[3] | May[4]; Columbia River (RM 515) |

[1]The 1.0M is an "up-to" value depending on funding. Presently, the first two years of production is funded at the 500K production level annually.
[2] Approximately 484,000 fish will be marked with CWT of the total Chinook subyearling production at Wells Hatchery including the SRKW Summer Chinook program.
[3]The acclimation timing for this program also includes timeframes for juvenile rearing because juvenile rearing and acclimation take place in the same facility.
[4]Volitional release occurs in mid-May.

Fish health staff monitor the fish throughout their rearing cycle for signs of disease. Mortalities are checked daily and live grab samples are taken monthly. Fish are also tested before release. Sampling, testing, and treatment/control procedures are outlined in and consistent with IHOT (1995); NWIFC and WDFW (2006); PNFHPC (1989).

### 1.2.4. **Proposed Disposition of Excess Juvenile and Adult Hatchery Fish**

Please refer to Table 4 regarding disposition protocols of surplus hatchery-origin fish to spawning needs, post-spawned fish, juveniles, and eggs. In general, hatchery practices are carefully managed to not produce fish in excess (over 10%) of hatchery goals.

**Table 4. Summary of disposition by life stage**

| Program(s) | Life stage | Disposition |
|---|---|---|
| **Wells Summer Chinook for SRKW** | Adults | Surplus fish removed at UCR hatcheries may be:<br>• used to support nutrient enhancement programs in the UCR<br>• given to the tribes or food banks<br>• sold to rendering companies<br>• or used for other hatchery programs as determined by the respective committees and/or co-managers<br>Nutrient enhancement programs are not within the current Proposed Action and will be consulted on in the future, when such plans are created[1] |
| | Juveniles/eggs | Rearing numbers are carefully managed, and surplus eggs and fish released are not expected to exceed 10%. In the case that excess eggs/fish occur, co-managers will inform regional staff and NOAA and an appropriate response will be discussed and decided upon. |

[1]Of note, these programs are likely to be in a form of direct carcass or a carcass analogue. If a nutrient enhancement program proposes to use direct carcass, the distribution will only occur within the space and temporal distribution of its natural counterpart spawning. If the program uses a carcass analogue, there would be no disease concerns because such carcass analogue will be processed to eliminate any pathogens.

### 1.2.5. **Proposed Research, Monitoring, and Evaluation (RM&E)**

- The program analyzed in this opinion will, in part, utilize data collected from the existing Wells yearling and subyearling summer Chinook RM&E programs consistent with the PUD M&E plan (Hillman et al. 2017a) and data collected by other RM&E programs operating in the Upper Columbia region. RM&E activities implemented by the programs are described below: Broodstock (and mortalities at trap locations) would be sampled to determine sex, fecundity, age, genetic identity and diversity, and stray rates.
- Spawning ground survey data (for carcass recovery and redd survey) collected in upper Columbia tributaries will be used to estimate location, number, stray rates, and timing of naturally-spawning summer Wells Hatchery summer Chinook salmon.
    - Carcass surveys and run composition assessment would be conducted in a manner to target about 10 to 20 percent of the escapement in a given area.
    - Determine hatchery fish effects on population productivity, genetic diversity, spawning distribution, and age and size at maturity.
- Evaluation of data collected by PIT-tag detection systems for the purposes of stray analysis, secondary smolt-to-adult return estimate, migration timing, juvenile survival, etc.
- Research to improve or assess program performance (such as different mating strategies to improve age at maturity, etc.).
- Monitoring of each life-stage survival rates in the hatchery.

### 1.2.6. **Proposed Operation, Maintenance, and/or Construction of Hatchery Facilities**

This hatchery program returns water to the diverted river (minus leakage or evaporation) along with any groundwater discharge. Water at all facilities is withdrawn in accordance with state-issued water rights. This program operates under an applicable National Pollutant Discharge Elimination System (NPDES) general permit. Minor armoring would be maintained at the fish ladders and effluent outfall. For additional information regarding facility water sources for the program, please refer to Table 5.

Several routine (and semi-routine) maintenance activities occur in or near water that could impact fish in the area including: sediment/gravel removal/relocation from intake and/or outfall structures, pond cleaning, pump maintenance, debris removal from intake and outfall structures, and maintenance and stabilization of existing bank protection. All in-water maintenance activities considered “routine” (occurring on an annual basis) or “semi-routine” (occurring with regularity, but not necessarily on an annual basis) for the purposes of this action will occur within existing structures or the footprint of areas that have already been impacted. In-water work will comply with state HPA and/or Department of Ecology authorizations as well as requirements by the USACE. While in-water maintenance activities are not likely to occur, they would comply with the following guidance if they were to occur:

- In-water work will:
    - Be done during the allowable freshwater work times established for each location, or comply with an approved variance of the allowable freshwater work times with the appropriate state agencies
    - Follow a pollution and erosion control plan that addresses equipment and materials storage sites, fueling operations, staging areas, cement mortars and bonding agents, hazardous materials, spill containment and notification, and debris management
    - Cease if ESA listed fish are observed to be in distress at any time as a result of the activities
    - Include notification of NMFS staff
- Equipment will:
    - Be inspected daily, and be free of leaks before leaving the vehicle staging area
    - Work above ordinary high water or in the dry whenever possible
    - Be sized correctly for the work to be performed and have approved oils / lubricants when working below the ordinary high water mark
    - Be staged and fueled in appropriate areas 150 feet from any water body
    - Be cleaned and free of vegetation before they are brought to the site and prior to removal from the project area

**Table 5. Facility water source and use for hatchery program operations (WDFW 2019)**

| Program | Facility | Surface Water | | | | | Ground Water (gpm) | | | Number and type of instream structures | Meet NMFS screening criteria[1] | NPDES Permit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Source and water right | Max use (cfs) | Diversion distance | Discharge location | Months utilized | Source and water right | Max use (cfs) | Months utilized | | | |
| **Wells Summer Chinook for SRKW** | Wells Hatchery[2] | Columbia River; S3-003620 and S4-26074 | 150 | ~650 ft. | Columbia River | 6 | Well field: G4-22856, G4-24462, G4-22857, G4-28847, G4-28598, G4-29184 | 38 | 12 | 3; intake, outfall, ladder | Yes | Yes |

[1]Older criteria are NMFS (1995a); NMFS (1996). Screens are checked throughout the year. If a screen fails or is determined to be inefficient, it must be replaced with one that meets NMFS' 2011 fish screen criteria.

[2]The operation of Wells Hatchery was analyzed in the 2017 Biological Opinion (NMFS 2017b).

### 1.3. Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. NMFS has not identified any interdependent or interrelated activities associated with the Proposed Action.

Fisheries are not part of this Proposed Action. Although fisheries target hatchery-origin returns from this program, harvest frameworks are managed separately from hatchery production, and are not solely tied to production numbers. Additionally, production and fishery implementation are subject to different legal mandates and agreements. Because of the complexities in annual management of the production and fishery plans, fisheries in these areas are considered a separate action.

There are also existing ocean fisheries that may catch fish from this program. However, these mixed fisheries would exist with or without this program, and have previously been evaluated in a separate biological opinion (NMFS 2008b). The impacts of fisheries in the Action Area on this program and, in particular, on ESA-listed salmonids returning to the Action Area for this opinion are included in the environmental baseline.

## 2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the FWS, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

### 2.1. Analytical Approach

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. "To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species or reduce the value of designated or proposed critical habitat (50 CFR 402.02).

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for

the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214, February 11, 2016).

The designations of critical habitat for the species considered in this opinion use the terms primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414, February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a Proposed Action is likely to jeopardize listed species or destroy or adversely modify critical habitat.

*Range-wide status of the species and critical habitat*

This section describes the status of species and critical habitat that are the subject of this opinion. The status review starts with a description of the general life history characteristics and the population structure of the ESU/DPS, including the strata or major population groups (MPG) where they occur. NMFS has developed specific guidance for analyzing the status of salmon and steelhead populations in a "viable salmonid populations" (VSP) paper (McElhany et al. 2000). The VSP approach considers four attributes, the abundance, productivity, spatial structure, and diversity of each population (natural-origin fish only), as part of the overall review of a species' status. For salmon and steelhead protected under the ESA, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of listed species, NMFS reviews available information on the VSP parameters including abundance, productivity trends (information on trends, supplements the assessment of abundance and productivity parameters), spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of the populations and ESU/DPS, and the limiting factors and threats. To source this information, NMFS relies on viability assessments and criteria in technical recovery team documents, ESA Status Review updates, and recovery plans. We determine the status of critical habitat by examining its PBFs . Status of the species and critical habitat are discussed in Section 2.2.

*Describing the environmental baseline*

The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the Action Area* on ESA-listed species. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.3 of this opinion.

*Cumulative effects*

Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area. Future Federal actions that are unrelated to the Proposed Action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.5 of this opinion.

*Integration and synthesis*

Integration and synthesis occurs in Section 2.6 of this opinion. In this step, NMFS adds the effects of the Proposed Action (Section 2.4) to the status of ESA protected populations in the Action Area under the environmental baseline (Section 2.3) and to cumulative effects (Section 2.5). Impacts on individuals within the affected populations are analyzed to determine their effects on the VSP parameters for the affected populations. These impacts are combined with the overall status of the MGP to determine the effects on the ESA-listed species (ESU/DPS), which will be used to formulate the agency's opinion as to whether the hatchery action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat.

*Jeopardy and adverse modification*

Based on the Integration and Synthesis analysis in section 2.6, the opinion determines whether the Proposed Action is likely to jeopardize ESA protected species or destroy or adversely modify designated critical habitat in Section 2.7.

*Reasonable and prudent alternative(s) to the Proposed Action*

If NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a RPA or RPAs to the Proposed Action.

## 2.2. Range-wide Status of the Species and Critical Habitat

This opinion examines the status of each species and designated critical habitat that would be affected by the Proposed Action described in Table 6[1]. Status of the species is the level of risk that the listed species face based on parameters considered in documents such as recovery plans, status reviews, and ESA listing determinations. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50

[1] ESA-listed bull trout (*Salvelinus confluentus*) are administered by the USFWS and the proposed hatchery program is currently covered under a separate USFWS Section 7 consultation

CFR 402.02. The opinion also examines the status and conservation value of critical habitat in the Action Area and discusses the current function of the essential physical and biological features that help to form that conservation value.

Table 6. Federal Register notices for the final rules that list species, designate critical habitat, or apply protective regulations to ESA-listed species considered in this consultation.

| Species | Listing Status | Critical Habitat | Protective Regulations |
|---|---|---|---|
| **Chinook salmon *(Oncorhynchus tshawytscha)*** | | | |
| Upper Columbia River Spring | Endangered<br>70 FR 37160; [1]<br>June 28, 2005 | 70 FR 52630;<br>Sept 2, 2005 | ESA Section 9 |
| **Steelhead *(O. mykiss)*** | | | |
| Upper Columbia River | Threatened<br>74 FR 42605; August 24, 2009 | 70 FR 52630; Sept 2, 2005 | 70 FR 37160; June 28, 2005 |

[1] Citations to "FR" are citations to the Federal Register.

*"Species" Definition:* The ESA of 1973, as amended, 16 U.S.C. 1531 *et seq.* defines "species" to include any "distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature." To identify DPSs of salmon species, NMFS follows the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612, November 20, 1991). Under this policy, a group of Pacific salmon is considered a DPS and hence a "species" under the ESA if it represents an evolutionarily significant unit (ESU) of the biological species. The group must satisfy two criteria to be considered an ESU: (1) It must be substantially reproductively isolated from other con-specific population units; and (2) It must represent an important component in the evolutionary legacy of the species. To identify DPSs of steelhead, NMFS applies the joint FWS-NMFS DPS policy (61 FR 4722, February 7, 1996). Under this policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

### 2.2.1. Status of Listed Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in

the natural environment. These parameters or attributes are substantially influenced by habitat and other environmental conditions.

"Abundance" generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment.

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally-spawning adults (i.e., progeny) produced per naturally spawning parental pair. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on accessibility to the habitat, on habitat quality and spatial configuration, and on the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000).

In describing the range-wide status of listed species, we rely on viability assessments and criteria in TRT documents and recovery plans, when available, that describe VSP parameters at the population, major population group (MPG), and species scales (i.e., salmon ESUs and steelhead DPSs). For species with multiple populations, once the biological status of a species' populations and MPGs have been determined, NMFS assesses the status of the entire species. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as meta-populations (McElhany et al. 2000).

#### 2.2.1.1. Upper Columbia River Spring Chinook Salmon ESU

Chinook salmon (*Oncorhynchus tshawytscha)* have a wide variety of life history patterns that include: variation in age at seaward migration; length of freshwater, estuarine, and oceanic residence; ocean distribution; ocean migratory patterns; and age and season of spawning migration. Two distinct races of Chinook salmon are generally recognized: "stream-type" and "ocean-type" (Healey 1991; Myers et al. 1998). ESA-listed UCR spring Chinook salmon are stream-type. Stream-type Chinook salmon rear for 1 year in freshwater, typically spend 2 to 3 years in coastal ocean waters, and enter freshwater in February through April. Spring Chinook salmon also spawn and rear high in the watershed..

The historical UCR Spring Chinook Salmon ESU comprises three major population groups (MPGs) and eight populations; however, the ESU is currently limited to one MPG (North

Cascade MPG) and three extant populations (Wenatchee, Methow and Entiat). The Okanogan population has been extirpated. For the MPG to be considered viable, all three extant populations are required to meet viability (i.e., no greater than a 5 percent extinction risk over a 100-year period) criteria (UCSRB 2007).

Approximately half of the area that originally produced spring Chinook salmon in this ESU is blocked by dams. What remains of the ESU includes all naturally spawned fish upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington State, excluding the Okanogan River (64 FR 14208, March 24, 1999) (Figure 2). The ESU originally included six artificial propagation programs: the Twisp, Chewuch, Methow Composite, Winthrop NFH, Chiwawa, and White River hatchery programs (79 FR 20802, April 14, 2014). Currently, the three Methow Subbasin programs (Twisp, Chewuch, Methow Composite) are considered a single program, with two components: Twisp and Methow/Chewuch (the previous Chewuch and Methow programs combined). Furthermore, a Nason Creek program began in the Wenatchee Subbasin (Grant County PUD et al. 2009b), while the White River releases were discontinued after 2015 (Grant County PUD et al. 2009a).

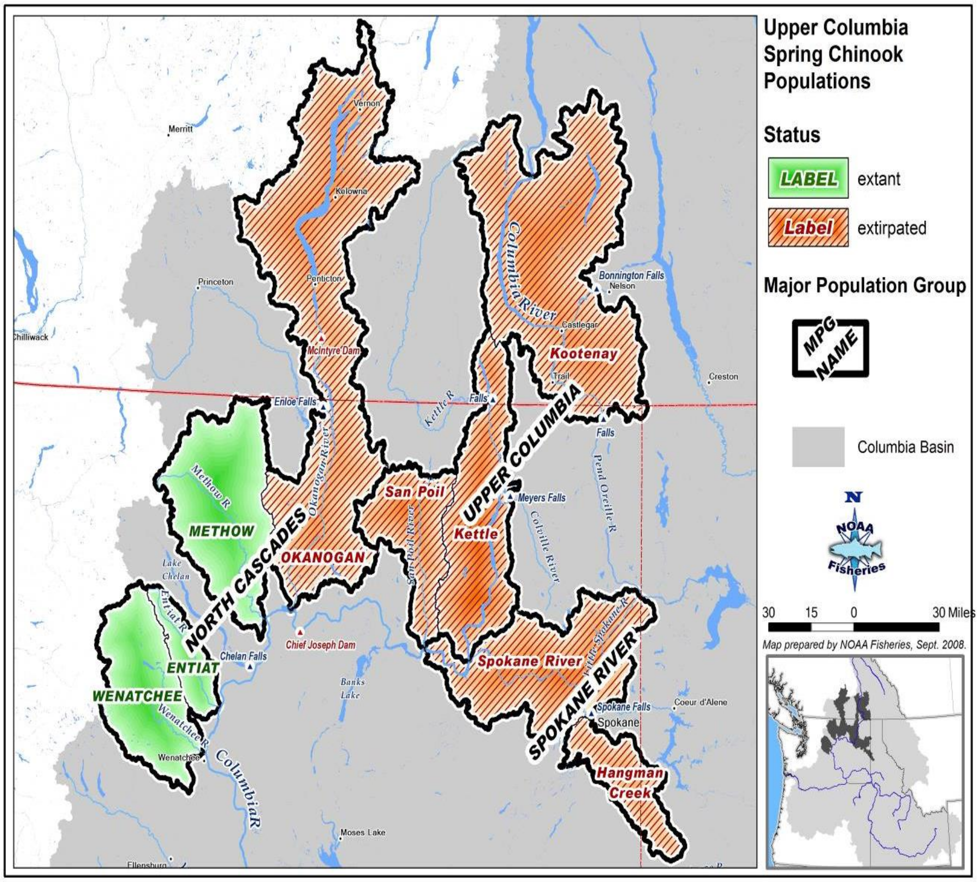


**Figure 2. Upper Columbia River Spring Chinook Salmon ESU (ICTRT 2008).**

For the most recent period (2005-2014), abundance has increased for all three populations, but productivity for all three populations remains below replacement (Table 7). Although increases in natural-origin abundance relative to the extremely low levels observed during the mid-1990s are encouraging, overall productivity has decreased to extremely low levels for the two largest populations (Wenatchee and Methow). The predominance of hatchery fish on the spawning grounds, particularly for the Wenatchee and Methow populations, is an increasing diversity risk, and populations that rely on hatchery spawners are not viable (McElhany et al. 2000). Natural-origin fish now make up fewer than fifty percent of the spawners for two of the three populations (Table 7). Based on the combined ratings for abundance/productivity and spatial structure/diversity, all three extant populations and the ESU remain at high risk of extinction (Table 7).

**Table 7. Risk levels and viability ratings for natural-origin UCR spring Chinook salmon populations from the North Cascades MPG (NWFSC 2015).**

| Population | Minimum Abundance Threshold | Spawning Abundance (2005-2014) | Productivity (2005-2014) | % Natural-origin spawners (2010-2014) | Overall Risk |
|---|---|---|---|---|---|
| Wenatchee River | 2000 | 545 (311-1030) | 0.60 | 35 | High |
| Entiat River | 500 | 166 (78-354) | 0.94 | 74 | High |
| Methow River | 2000 | 379 (189-929) | 0.46 | 27 | High |
| Okanogan | 750 | Extirpated | | | |

Many factors affect the abundance, productivity, spatial structure, and diversity of the UCR Spring Chinook Salmon ESU. Factors limiting the ESU's survival and recovery include:

- past management practices such as the Grand Coulee Fish Maintenance Project
- survival through the FCRPS
- degradation and loss of estuarine areas that help the fish survive the transition between fresh and marine waters
- spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, and high quality spawning gravels
- interbreeding and competition with hatchery fish that far outnumber fish from natural populations.

### 2.2.1.2. Upper Columbia River Steelhead DPS

Steelhead (*O. mykiss*) occur as two basic anadromous run types based on the level of sexual maturity at the time of river entry and the duration of the spawning migration (Burgner et al. 1992). The stream-maturing type (inland), or summer steelhead, enters freshwater in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type (coastal), or winter steelhead, enters freshwater with well-developed gonads and spawns shortly after river entry (Barnhart 1986).

UCR steelhead are summer steelhead, returning to freshwater between May and October, and require up to 1 year in freshwater to mature before spawning (Chapman et al. 1994). Spawning occurs between January and June. In general, summer steelhead prefer smaller, higher-gradient streams relative to other Pacific salmon, and they spawn farther upstream than winter steelhead (Behnke and American Fisheries Society 1992; Withler 1966). Progeny typically reside in freshwater for two years before migrating to the ocean, but freshwater residence can vary from 1-7 years (Peven et al. 1994). For UCR steelhead, marine residence is typically one year, although the proportion of two-year ocean fish can be substantial in some years. They migrate directly offshore during their first summer rather than migrating nearer to the coast as do salmon. During fall and winter, juveniles move southward and eastward (Hartt and Dell 1986).

The UCR Steelhead DPS includes all naturally spawned steelhead populations below natural and man-made impassable barriers in streams in the Columbia River Basin upstream of the Yakima River, Washington to the U.S.–Canada border. The UCR Steelhead DPS also includes six artificial propagation programs: the Wenatchee River, Wells Hatchery (in the Methow, Columbia and Okanogan rivers [including Omak Creek]), WNFH, and the Ringold steelhead hatchery programs.

The UCR Steelhead DPS consisted of three MPGs before the construction of Grand Coulee Dam, but it is currently limited to one MPG with four extant populations: Wenatchee, Methow, Okanogan, and Entiat. A fifth population in the Crab Creek drainage is believed to be functionally extinct. What remains of the DPS includes all naturally spawned populations in all tributaries accessible to steelhead upstream from the Yakima River in Washington State, to the U.S. – Canada border (

Figure **3**).

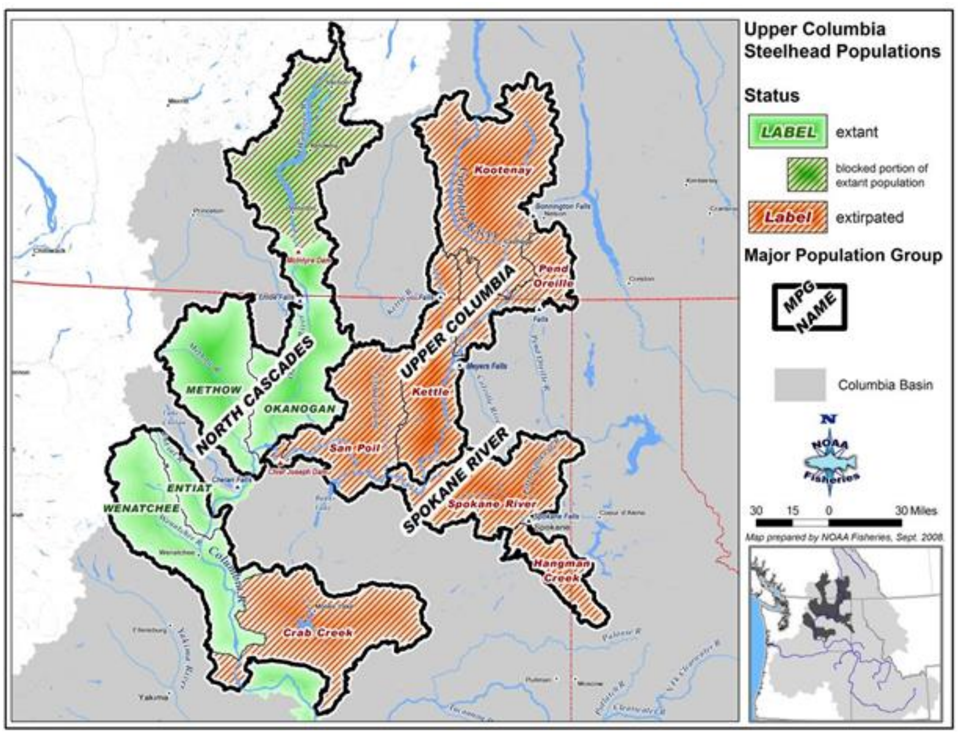


**Figure 3. Upper Columbia River Steelhead DPS (ICTRT 2008).**

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the UCR Steelhead DPS is at high risk and remains at threatened status. The ESA Recovery Plan (UCSRB 2007) requires each of the four extant steelhead populations to be viable. For the 2005-2014 period, abundance has increased for natural-origin spawners in each of the four extant

populations (Table 8). However, natural-origin returns remain well below target levels for three of the four populations. Productivity remained the same for three of the four populations and decreased for the Entiat population relative to the last review (Ford et al. 2011). For spatial structure and diversity, hatchery origin returns continue to constitute a high fraction (Table 8) of total spawners in natural spawning areas for the DPS as a whole (NWFSC 2015). The predominance of hatchery fish on the spawning grounds is an increasing risk, and populations that rely solely on hatchery spawners are not viable over the long-term (McElhany et al. 2000). Based on the combined ratings for abundance/productivity and spatial structure/diversity, three of the four extant populations and the DPS remain at high risk of extinction.

**Table 8. Risk levels and viability ratings for natural-origin UCR steelhead populations (NWFSC 2015).**

| Population | Minimum Abundance Threshold | Spawning Abundance (2005-2014) | Productivity (2005-2014) | % Natural-origin spawners (2010-2014) | Overall Risk |
|---|---|---|---|---|---|
| Wenatchee River | 1000 | 1025 (386-2235) | 1.207 | 58 | Maintained |
| Entiat River | 500 | 146 (59-310) | 0.434 | 31 | High |
| Methow River | 1000 | 651 (365-1105*)* | 0.371 | 24 | High |
| Okanogan River | 750 | 189 (107-310) | 0.154 | 13 | High |

Many factors affect the abundance, productivity, spatial structure, and diversity of the UCR Steelhead DPS. Factors limiting the DPS's survival and recovery include:

- past management practices such as the Grand Coulee Fish Maintenance Project
- survival through the FCRPS
- degradation and loss of estuarine areas that help the fish survive the transition between fresh and marine waters
- spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, and high quality spawning gravels
- predation by native and non-native species
- harvest
- interbreeding and competition with hatchery fish that far outnumber fish from natural populations

### 2.2.2. Range-wide Status of Critical Habitat

NMFS determines the range-wide status of critical habitat by examining the condition of its PBFs that were identified when critical habitat was designated. These features are essential to the conservation of the listed species because they support one or more of the species' life stages. An example of some PBFs are listed below. These are often similar among listed salmon and steelhead; specific differences can be found in the critical habitat designation for each species.

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

(2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;

(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;

(4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation;

(5) Near-shore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels;

(6) Offshore marine areas with water-quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The status of critical habitat is based primarily on a watershed-level analysis of conservation value that focused on the presence of ESA-listed species and physical features that are essential to the species' conservation. NMFS organized information at the 5th field hydrologic unit code (HUC) watershed scale because it corresponds to the spatial distribution and site fidelity scales of salmon and steelhead populations (McElhany et al. 2000). The analysis for the 2005 designations of salmon and steelhead species was completed by Critical Habitat Analytical Review Teams (CHARTs) that focused on large geographical areas corresponding approximately to recovery domains (NMFS 2005b). Each watershed was ranked using a conservation value attributed to the quantity of stream habitat with physical and biological features (PBFs; also known as primary and constituent elements ((PCEs)), the present condition of those PBFs, the likelihood of achieving PBF potential (either naturally or through active restoration), support for rare or important genetic or life history characteristics, support for abundant populations, and support for spawning and rearing populations. In some cases, our understanding of these interim conservation values has been further refined by the work of technical recovery teams and other recovery planning efforts that have better explained the habitat attributes, ecological interactions, and population characteristics important to each species.

The HUCs that have been identified as critical habitat for these species are largely ranked as having high conservation value. Conservation value reflects several factors: (1) how important the area is for various life history stages, (2) how necessary the area is to access other vital areas of habitat, and (3) the relative importance of the populations the area supports relative to the overall viability of the ESU or DPS.

**Critical Habitat for Upper Columbia River Spring Chinook Salmon**

The UCR Spring Chinook Salmon ESU's range consists of 31 watersheds. The CHART assigned 5 watersheds a medium rating, and 26 received a high rating of conservation value to the ESU (NMFS 2005a). The following are the major factors limiting the conservation value of UCR spring Chinook salmon critical habitat:

- Forestry practices
- Fire activity and disturbance
- Livestock grazing
- Agriculture
- Channel modifications/diking
- Road building/maintenance
- Urbanization
- Sand and gravel mining
- Mineral mining
- Dams
- Irrigation impoundments and withdrawals

**Critical Habitat for Upper Columbia River Steelhead**

The UCR Steelhead DPS's range includes 42 watersheds. The CHART assigned low, medium, and high conservation value ratings to 3, 8, and 31 watersheds, respectively (NMFS 2005a). The following are the major factors limiting the conservation value of critical habitat for UCR steelhead:

- Forestry practices
- Livestock grazing
- Agriculture
- Channel modifications/diking
- Road building/maintenance
- Urbanization
- Sand and gravel mining
- Mineral mining
- Dams
- Irrigation impoundments and withdrawals
- River, estuary, and ocean traffic

- Wetland loss/removal
- Beaver removal
- Exotic/invasive species introductions
- Forage fish/species harvest

### 2.2.3. Climate Change

Climate change has negative implications for salmonid species and designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004; ISAB 2007; Scheuerell and Williams 2005; Zabel et al. 2006). For a detailed discussion of climate change and how it affects salmonid species in the Pacific Northwest, see below in Section 2.4.2.

## 2.3. Action Area

The "Action Area" means all areas to be affected directly or indirectly by the Proposed Action, in which the effects of the action can be meaningfully detected measured, and evaluated (50 CFR 402.02). The Action Area resulting from this analysis includes the mainstem Columbia River from the release site at Wells Hatchery down to the confluence with the Snake River. Because the releases are high up in the Upper Columbia River and total one million subyearling releases, we do not believe there are any discernible effects on ESA listed salmon and steelhead downstream of the Snake River. Downstream effects have been modeled in the Biological Opinion on the Mitchell Act Funded Hatchery programs (NMFS 2017e) as well as the *United States v Oregon* Biological Opinion (NMFS 2018), which support idea conclusion that there would unlikely be discernible effects from this program on EA listed salmon and steelhead downstream of the Snake River.

The Action Area also includes the Okanogan, Methow, Chelan, Entiat, and Wenatchee Subbasins and their tributaries, which are areas where they may be monitored or might stray. In addition we are also including the estuary (i.e., mouth of the Columbia River) which is an area where returning adults from this Proposed Action will concentrate and Southern Resident Killer Whales may prey on them. This results in a discontiguous Action Area for listed salmonids in the Upper Columbia River basin and Southern Resident Killer Whales in the estuary.

## 2.4. Environmental Baseline

Under the Environmental Baseline, NMFS describes what is affecting listed species and designated critical habitat before including any effects resulting from the Proposed Action. The 'Environmental Baseline' includes the past and present impacts of all Federal, state, or private actions and other human activities in the Action Area and the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation (50 CFR 402.02).

### 2.4.1. Habitat and Hydropower

A discussion of the baseline condition of habitat and hydropower throughout the Columbia River Basin occurs in our Biological Opinion on the Mitchell Act Hatchery programs (NMFS 2017e). Here we summarize some of the key impacts on salmon and steelhead habitat in the Action Area.

Anywhere hydropower exists, some general effects exist on salmon habitat, though those effects vary depending on the hydropower system. In the Action Area, some of these general effects from hydropower systems on biotic and abiotic factors include, but are not limited to:

- Juvenile and adult passage survival (safe passage in the migration corridor);
- Water quantity (i.e., flow) and seasonal timing (water quantity and velocity and safe passage in the migration corridor; cover/shelter, food/prey, riparian vegetation, and space associated with the connectivity of the estuarine floodplain);
- Temperature in the reaches below the large mainstem storage projects (water quality and safe passage in the migration corridor)
- Sediment transport and turbidity (water quality and safe passage in the migration corridor)
- Total dissolved gas (water quality and safe passage in the migration corridor)
- Food webs, including both predators and prey (food/prey and safe passage in the migration corridor)

While harmful land-use practices continue in some areas, many land management activities, including forestry practices, now have fewer impacts on salmonid habitat due to raised awareness and less invasive techniques. For example, timber harvest on public land has declined drastically since the 1980s and current harvest techniques (e.g., the use of mechanical harvesters and forwarders) and silvicultural prescriptions (i.e., thinning and cleaning) require little, if any, road construction and produce much less sediment. In addition, the Federal Conservation Reserve and Enhancement Program (CREP) began in the 1990's nearly 80 percent of all salmonid bearing streams in the area have been re-vegetated with native species and protected from impacts. Under the CREP, highly erodible and other environmentally sensitive lands that have produced crops are converted to a long-term resource-conserving vegetative cover. Participants in the CREP are required to seed native or introduced perennial grasses or a combination of shrubs and trees with native forbs and grasses.

**Upper Columbia River**

Many factors have contributed to habitat degradation in the Wenatchee, Entiat, Methow, and Okanogan subbasins. The historical land use patterns are similar in each; beaver trapping, which began in the early 1800s, had some effect on riparian conditions. Mining, which began in the 1860s, was probably the first major activity affecting riparian and stream conditions. This was followed by a period of intense livestock grazing with pressure highest from the late 1800s to the 1930s. Grazing pressure then fell as allotment systems replaced the open range. Water diversion began in the mid-1880s, affecting stream flow, which impacted adult salmonid migration and juvenile rearing capacity. Timber harvest began in the 1920s and up until 1955 selective harvest

was the primary method. Since then partial cutting and clear-cutting have predominated, with the most intense harvest occurring in the 1980s. Some of these factors have been partially addressed through changes in land-use practices and/or implementation of BMPs (e.g., fish screens at water diversions; UCSRB 2014). In addition, some of the headwater areas are in relatively pristine condition and serve as strongholds for the listed species. However, many of the factor effects remain as a result of remnant infrastructure and previous land conversion/modifications (UCSRB 2007).

Limits to the viability of salmon and steelhead in the Wenatchee Basin include lack of habitat diversity and quantity, excessive sediment load, obstructions, a lack of channel stability, low flows, and high summer temperatures. Habitat diversity is affected by channel confinement, loss of floodplain connectivity and off-channel habitat, reduced quantities of large wood, and a lack of riparian vegetation. The mainstem and many of its tributaries also lack high-quality pools and spawning areas.

Limits to the viability of salmon and steelhead in the Entiat Basin include reduced stream channel configuration and complexity due to logging and flood control measures. These historical and ongoing activities have led to a condition with low instream habitat diversity including few pools, lack of large wood accumulations, and disconnected side channels, wetlands, and floodplains. The result is a reduction in resting and rearing areas for both adult and juvenile salmon throughout the Entiat River.

Limits to the viability of salmon and steelhead in the Methow basin include housing and agricultural development that have diminished the overall function of the stream channel and floodplain. This has impaired stream complexity, wood and gravel recruitment, floodwater retention, and water quality. Additionally, late summer and winter instream flow conditions often reduce migration, spawning, and rearing habitat for native salmonids. This problem is partly natural (a result of watershed-specific weather and geomorphic conditions) but is exacerbated by irrigation withdrawals.

Limits to the viability of salmon and steelhead in the Okanogan Basin include barriers, poor water quality, and low late-summer instream flows (mainstem and tributary). Summer water temperatures often exceed lethal tolerance levels for salmonids in the Okanogan River mainstem. These high temperatures are partially due to natural phenomena (low gradient, aspect, high ambient air temperatures, and upstream lake effects), but are exacerbated by activities like dam operations, irrigation, and land management. High water temperatures and low flows in summer and fall may limit adult run timing as well as juvenile salmonid rearing in the mainstem and in several tributaries.

### 2.4.2. Climate Change

Climate change has negative implications for designated critical habitats in the Pacific Northwest (ISAB 2007; Scheuerell and Williams 2005; Zabel et al. 2006). During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas. As the

climate changes, air temperatures in the Pacific Northwest are expected to increase <1°C in the Columbia Basin by the 2020s and 2°C to 8°C by the 2080s (Mantua et al. 2010). Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009). While total precipitation changes are uncertain, increasing air temperature will result in more precipitation falling as rain rather than snow in watersheds across the basin (NMFS 2015b).

These changes will not be spatially homogenous across the entire Pacific Northwest. There is likely no trend in precipitation (neither strongly increase nor decrease), although summers may become drier and winters wetter due to changes in the same amount of precipitation being subjected to altered seasonal temperatures (Mote and Eric P. Salathé Jr. 2010; PCIC 2016). Warmer winters will result in reduced snowpack throughout the Pacific Northwest, leading to substantial reductions in stream volume and changes in the magnitude and timing of low and high flow patterns (Beechie et al. 2013; Dalton et al. 2013). Many basins that currently have a snowmelt-dominated hydrological regime (maximum flows during spring snow melt) will become either transitional (high flows during both spring snowmelt and fall-winter) or rain-dominated (high flows during fall-winter floods; (Beechie et al. 2013; Schnorbus et al. 2014). Summer low flows are expected to be reduced between 10-70% in areas west of the Cascade Mountains over the next century, while increased precipitation and snowpack is expected for the Canadian Rockies. More precipitation falling as rain and larger future flood events are expected to increase maximum flows by 10-50% across the region (Beechie et al. 2013). Climate change is also predicted to increase the intensity of storms, reduce winter snow pack at low and middle elevations, and increase snowpack at high elevations in northern areas. Middle and lower elevation streams will have larger fall/winter flood events and lower late summer flows, while higher elevations may have higher minimum flows.

The effects of climate change are likely to be already occurring, though the effects are difficult to distinguish from effects of climate variability in the near term. Climate change is currently causing, and is predicted to cause in the future, a variety of impacts on Pacific salmon as well as their ecosystems (Crozier et al. 2008a; Martins et al. 2012; Mote et al. 2003; Wainwright and Weitkamp 2013). While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some impacts (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat-specific (e.g., stream flow variation in freshwater). Effects are likely to include:

- Warmer air temperatures will result in diminished snowpacks and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, seasonal hydrology in Pacific Northwest watersheds will shift to more frequent and severe early large storms, changing stream flow timing, which may limit salmon survival (Mantua et al. 2009).
- Water temperatures are expected to rise, especially during the summer months when lower streamflows co-occur with warmer air temperatures.

- More frequent high intensity wildfires may also significantly change the landscape to promote more erosion and result is less large woody debris recruitment.

The complex life cycles of anadromous fishes, including salmon, rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments. The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- Direct effects of increased water temperatures on fish physiology
- Temperature-induced changes to stream flow patterns
- Alterations to freshwater, estuarine, and marine food webs

How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). Dittmer (2013) suggests that juveniles may outmigrate earlier if they are faced with less tributary water. Lower and warmer summer flows may be challenging for returning adults. In addition, the warmer water temperatures in the summer months may persist for longer periods and more frequently reach and exceed thermal tolerance thresholds for salmon and steelhead (Mantua et al. 2009). Larger winter streamflows may increase redd scouring for those adults that do reach spawning areas and successfully spawn. Climate change may also have long-term effects that include accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007). The uncertainty associated with these potential outcomes of climate change do provide some justification for hatchery programs as reservoirs for some salmon stocks. For more detail on climate change effects, see NMFS (2017e).

### 2.4.3. Hatcheries

A broader discussion of hatchery programs in the Action Area can be found in our opinions on:

- Mitchell Act-funded programs (NMFS 2017e).
- *United States v Oregon* Biological Opinion (NMFS 2018)
- Four Summer/Fall Chinook Salmon and Two Fall Chinook Salmon Hatchery Programs in the Upper Columbia River Basin (NMFS 2017b)
- Methow/Winthrop spring Chinook salmon programs (NMFS 2016b).
- WNFH/Wells Complex steelhead programs (NMFS 2017f).
- Entiat National Fish Hatchery summer Chinook salmon program (NMFS 2013b).
- Wenatchee spring Chinook salmon programs (NMFS 2013a).
- Wenatchee steelhead program (NMFS 2016a).
- Upper Columbia River unlisted spring chinook salmon, summer chinook salmon, fall chinook salmon, coho salmon, and sockeye salmon Yakama Nation hatchery programs (NMFS 2003a)

- Confederated Tribes of the Colville Reservation TRMP (NMFS 2017d)

Included in the Environmental Baseline are the ongoing effects of hatchery programs or facilities that have undergone Federal review under the ESA, as well as the past effects of programs that have not yet undergone such review. A more comprehensive discussion of hatchery programs in the Columbia Basin can be found in our opinion on Mitchell Act funded programs (NMFS 2017e). In summary, because most programs are ongoing, the effects of each are reflected in the most recent status of the species (NWFSC 2015) and were summarized in Section 2.2.1 of this Opinion. In the past, hatcheries have been used to compensate for factors that limit anadromous salmonid viability (e.g., harvest, human development) by maintaining fishable returns of adult salmon and steelhead. A new role for hatcheries emerged during the 1980s and 1990s as a tool to conserve the genetic resources of depressed natural populations and to reduce short-term extinction risk (e.g., Snake River sockeye salmon). Hatchery programs also can be used to help improve viability by supplementing natural population abundance and expanding spatial distribution. However, the long-term benefits and risks of hatchery supplementation remain untested (Christie et al. 2014). Therefore, fixing the factors limiting viability is essential for long-term viability.

Below, we summarize releases within the Action Area in the UCR Basin (Table 9) because the release from the Proposed Action is in the UCR Basin, and the returning adults from the Proposed Action would return to the UCR Basin.

Table 9. Upper Columbia River hatchery programs with releases in the Action Area.

| Biological Opinion | Program Name | Maximum Release Level |
|---|---|---|
| Wells Complex and WNFH steelhead programs (NMFS 2017f) | Wells Complex[1] | 308,000 |
| | Winthrop National Fish Hatchery | 200,000 |
| Entiat National Fish Hatchery summer Chinook salmon program (NMFS 2013b) | Entiat National Fish Hatchery | 400,000 |
| Chelan Falls summer Chinook program (NMFS 2017b) | Chelan Falls Hatchery | 576,000 |
| Wenatchee summer Chinook program (NMFS 2017b) | Wenatchee/Eastbank Fish Hatchery | 500,001 |
| Wenatchee spring Chinook salmon programs (NMFS 2013a) | Chiwawa | 205,000 |
| | Nason Creek | 223,760 |
| Wenatchee steelhead program (NMFS 2016a) | Wenatchee | 247,300 |
| Leavenworth spring Chinook salmon program (NMFS 2017c) | Leavenworth National Fish Hatchery | 1,200,000 |
| Methow Hatchery Spring Chinook (NMFS 2016a) | Methow Hatchery | 223,765 |
| CTCR TRMP hatchery programs (NMFS 2017d) | Spring Chinook | 700,000 |
| | Summer/fall Chinook | 2,000,000 |

| Biological Opinion | Program Name | Maximum Release Level |
|---|---|---|
| | Steelhead | 100,000 |

[1] The Wells Complex steelhead program produces an additional 100,000 smolts, which is transferred for release in the Okanogan Basin (NMFS 2017d).

Encounters of UCR spring Chinook salmon during broodstock collection for summer Chinook salmon occur concurrently with RM&E associated with the spring Chinook salmon. These effects are included in the Biological Opinions on the Methow/Winthrop spring Chinook salmon programs (NMFS 2016b) and the WNFH/Wells Complex steelhead programs (NMFS 2017f).

### 2.4.4. Harvest

Fisheries within the Action Area that harvest or encounter ESA-listed fish include fisheries above Priest Rapids Dam.

**Fisheries above Priest Rapids Dam**

Fisheries above Priest Rapids Dam occur both on the Columbia River and on its tributaries. Within this area, there are mark-selective spring Chinook salmon and steelhead fisheries and various fisheries targeting non-ESA-listed fish.

ESA-listed UCR spring Chinook salmon are not harvested in the Action Area above Priest Rapids Dam. Mark-selective steelhead fisheries operate in the Action Area under permit 1395 (NMFS 2003b). Allowable incidental take is based on natural-origin returns, with the idea being that as the number of natural-origin returns increases, a higher percentage of natural-origin fish is allowed to be encountered in the fishery. There are no encounters with spring Chinook salmon because these fisheries occur from September through March (before and after spring Chinook salmon return to this area), although seasons are often shorter because of in-season management of steelhead returns. Table 10 summarizes the incidental take associated with the mark-selective steelhead fisheries from 2010 through 2016.

Table 10. Summary of natural-origin UCR steelhead encounters associated with mark-selective steelhead fisheries above Priest Rapids Dam (2010-2016).

| Season | Area | Natural-origin escapement | Allowable incidental take | Realized incidental take[1] |
|---|---|---|---|---|
| **2010-2011** | **Methow River** | **1773** | **71** | **70** |
| | **Columbia River[1]** | **4050** | **81** | **34** |
| **2011-2012** | **Methow River** | **1187** | **24** | **24** |
| | **Columbia River[2]** | **1185** | **24** | **10** |
| **2012-2013** | **Methow River** | **905** | **18** | **14** |
| | **Columbia River[2]** | **545** | **11** | **12** |
| **2013-2014** | **Methow River** | **1481** | **30** | **23** |
| | **Columbia River[3]** | **359** | **7** | **5** |
| **2014-2015** | **Methow River** | **2168** | **43** | **17** |

| Season | Area | Natural-origin escapement | Allowable incidental take | Realized incidental take[1] |
|---|---|---|---|---|
| | **Columbia River[3]** | **283** | **6** | **8** |
| **2015-2016** | **Methow River** | **1248** | **25** | **25** |
| | **Columbia River[3]** | **98** | **2** | **4** |

Sources:WDFW (2011); WDFW (2012); WDFW (2014a); WDFW (2015a); WDFW (2016a)
[1] Based on 5 percent assumed catch and release mortality.
[2] This includes the reach from Priest to Wells Dam and the Entiat River.
[3] This includes the reach from Rock Island to Wells Dam.

The Wenatchee River also has a conservation fishery that may impact ESA-listed steelhead, which was analyzed in NMFS (2013a), and which found that up to 10 natural-origin adult UCR steelhead may be caught and released, with no more than 1 percent incidental mortality.

In this area, there are four other fisheries that incidentally impact ESA-listed spring Chinook salmon and steelhead. The Methow River resident trout fishery, which occurs from June through September, has incidentally killed up to 650 juveniles and encountered up to 12 adult steelhead annually over the last five years, and remains within their allowed take through NMFS permit 1554 (Table **11**). The summer Chinook and sockeye salmon fishery has incidentally killed up to 10 adult steelhead annually (Table **11**), which is within their allotted take under permit 1554 (NMFS 2008e). This fishery is unlikely to encounter spring Chinook salmon because it operates from July to October after spring Chinook salmon have already entered or spawned in the tributary habitats, and does not take place in the Methow River. Another fishery operating under permit 1554 is a recreational fishery targeting non-ESA listed spring Chinook salmon (Carson stock) in Icicle Creek, which has encountered spring Chinook salmon and steelhead in the past (The non-game fishery above Priest Rapids has not resulted in take of listed spring Chinook salmon and steelhead despite operating year-round (WDFW 2013; WDFW 2014b; WDFW 2015b; WDFW 2016b; WDFW 2017a). In addition, there are Confederated Tribes of the Colville Reservation (CTCR) fisheries in the Upper Columbia River. These fisheries target summer Chinook and may incidentally encounter ESA-listed spring Chinook salmon and steelhead through a purse seine fishery in the mouth of the Okanogan and a snag fishery below Chief Joseph Dam (NMFS 2017d).

**Table 11. Summary of natural-origin UCR steelhead and UCR spring Chinook salmon encounters associated with fisheries targeting non-listed fish above Priest Rapids Dam (2012-2016).**

| Year | Fishery | Allowable steelhead | Realized steelhead | Allowable spring Chinook salmon | Realized spring Chinook salmon |
|---|---|---|---|---|---|
| **2012** | **Methow River resident trout** | **1250 juveniles 20 adults** | **429 juveniles 12 adults** | **8 juveniles** | **0 juveniles** |
| | **Summer Chinook and sockeye salmon** | **10 adults** | **9 adults** | **0** | **0** |

| Year | Fishery | Allowable steelhead | Realized steelhead | Allowable spring Chinook salmon | Realized spring Chinook salmon |
|---|---|---|---|---|---|
| | Icicle Creek spring Chinook salmon | 10 adults | 0 | 3 adults | 1 adult |
| 2013 | Methow River resident trout | 1250 juveniles 20 adults | 650 juveniles 12 adults | 8 juveniles | 8 juveniles |
| | Summer Chinook and sockeye salmon | 10 adults | 4 adults | 0 | 0 |
| | Icicle Creek spring Chinook salmon | 10 adults | 14 adults | 3 adults | No information |
| 2014 | Methow River resident trout | 1250 juveniles 20 adults | 302 juveniles 4 adults | 8 juveniles | 8 juveniles |
| | Summer Chinook and sockeye salmon | 10 adults | 10 adults | 0 | 0 |
| | Icicle Creek spring Chinook salmon | 10 adults | 0 | 3 adults | No information |
| 2015 | Methow River resident trout | 1250 juveniles 20 adults | 396 juveniles 0 adults | 8 juveniles | 2 juveniles |
| | Summer Chinook and sockeye salmon | 10 adults | 9 adults | 0 | 0 |
| | Icicle Creek spring Chinook salmon | 10 adults | 0 | 3 adults | No information |
| 2016 | Methow River resident trout | 1250 juveniles 20 adults | 495 juveniles 0 adults | 8 juveniles | 4 juveniles |
| | Summer Chinook and sockeye salmon | 10 adults | 3 adults | 0 | 0 |
| | Icicle Creek spring Chinook salmon | 10 adults | 2 adults | 3 adults | No information |

Sources: WDFW (2013); WDFW (2014b); WDFW (2015b); WDFW (2016b); WDFW (2017a)

## 2.5. Effects on ESA Protected Species and on Designated Critical Habitat

This section describes the effects of the Proposed Action, independent of the Environmental Baseline and Cumulative Effects. The methodology and best scientific information NMFS follows for analyzing hatchery effects is summarized in Appendix A and application of the methodology and analysis of the Proposed Action is in Section 2.4.2. The "effects of the action" means the direct and indirect effects of the action on the species and on designated critical habitat, together with the effects of other activities that are interrelated or interdependent, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur. Effects of the Proposed Action that are expected to occur later in time (i.e., after the 10-year timeframe of the Proposed Action) are included in the analysis in this opinion to the extent they

can be meaningfully evaluated. The Proposed Action, the status of ESA-protected species and designated critical habitat, the Environmental Baseline, and the Cumulative Effects are considered together to determine whether the Proposed Action is likely to appreciably reduce the likelihood of survival and recovery of ESA protected species or result in the destruction or adverse modification of their designated critical habitat.

### 2.5.1. Factors That Are Considered When Analyzing Hatchery Effects

NMFS has substantial experience with hatchery programs and has developed and published a series of guidance documents for designing and evaluating hatchery programs following best available science (Hard et al. 1992; Jones 2006; McElhany et al. 2000; NMFS 2004; NMFS 2005b; NMFS 2008a; NMFS 2011). For Pacific salmon, NMFS evaluates extinction processes and effects of the Proposed Action beginning at the population scale (McElhany et al. 2000). NMFS defines population performance measures in terms of natural-origin fish and four key parameters or attributes; abundance, productivity, spatial structure, and diversity and then relates effects of the Proposed Action at the population scale to the MPG level and ultimately to the survival and recovery of an entire ESU or DPS.

"Because of the potential for circumventing the high rates of early mortality typically experienced in the wild, artificial propagation may be useful in the recovery of listed salmon species. However, artificial propagation entails risks as well as opportunities for salmon conservation" (Hard et al. 1992). A Proposed Action is analyzed for effects, positive and negative, on the attributes that define population viability: abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS and designated critical habitat "will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes" (70 FR 37215, June 28, 2005). The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. "Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU".

NMFS' analysis of the Proposed Action is in terms of effects it would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. This allows for quantification (wherever possible) of the effects of the seven factors of hatchery operation on each listed species at the population level (in Section 2.5.2), which in turn allows the combination of all such effects with other effects accruing to the species to determine the likelihood of posing jeopardy to the species as a whole (Section **2.8**).

Information that NMFS needs to analyze the effects of a hatchery program on ESA-listed species must be included in an HGMP. Draft HGMPs are reviewed by NMFS for their sufficiency before formal review and analysis of the Proposed Action can begin. Analysis of an HGMP or Proposed

Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, migratory corridor, estuary, and ocean
(4) RM&E that exists because of the hatchery program
(5) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program
(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds

NMFS analysis assigns an effect category for each factor (negative, negligible, or positive/beneficial) on population viability. The effect category assigned is based on: (1) an analysis of each factor weighed against the affected population(s) current risk level for abundance, productivity, spatial structure, and diversity; (2) the role or importance of the affected natural population(s) in salmon ESU or steelhead DPS recovery; (3) the target viability for the affected natural population(s) and; (4) the Environmental Baseline, including the factors currently limiting population viability. For more information on how NMFS evaluates each factor, please see Appendix A.

### 2.5.2. Effects of the Proposed Action

This section discusses the effects of the Proposed Action on the ESA-listed species, Upper Columbia River spring Chinook salmon and Upper Columbia River steelhead, in the Action Area.

#### 2.5.2.1. Factor 1. The hatchery program does or does not remove fish from the natural population and use them for broodstock

Because the program in this Proposed Action propagates non-ESA-listed summer Chinook salmon, which is a different species/run of salmonid than the listed Upper Columbia River spring Chinook salmon and steelhead, no fish from natural populations of listed species will be removed for hatchery broodstock. Therefore, there is no overall effect of this factor on these species. Inadvertent collection of listed species will be considered under Factor 2.

#### 2.5.2.2. Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

The proposed hatchery program poses ecological risks and risks from handling related to adult collection to UCR spring Chinook salmon and UCR steelhead, while posing no genetic risks because the species propagated does not interbreed with any ESA-listed individuals. The overall effect of this factor on these Upper Columbia River species is negligible.

**Genetic Effects**

Because the fish from the Proposed Action return to the UCR Basin as an adult to potentially spawn, only listed species that are present in UCR (i.e., UCR spring Chinook salmon and UCR steelhead) have the potential to be affected genetically by the Proposed Action. Within the UCR Basin, there is a possibility that late returning spring Chinook salmon could interbreed with summer Chinook salmon from the early part of the run (Table 12) in some areas where spatial and temporal spawning distributions overlap. However, based on spring Chinook salmon spawning timing in subbasins where hatchery summer Chinook salmon are released (e.g., Snow et al. (2016), Hillman et al. (2016)), there is little to no temporal overlap with summer Chinook salmon spawning, so interbreeding between hatchery-origin summer Chinook salmon and UCR spring Chinook salmon is unlikely.

Table 12. Timing of adult return and spawning for UCR salmonids.

| Fish Run and Species | Freshwater Entry | Spawning Duration | Spawning Peak |
|---|---|---|---|
| Summer/fall Chinook Salmon | June to August | Late September to end of November | Early to mid-October |
| Fall Chinook Salmon | Mid-August to October | Late October to early December | November |
| Spring Chinook Salmon | May to June | Early August to mid-September | Mid to late August |
| Summer Steelhead | July to mid-June | March to mid-July | April to May |

Sources: (WDFW 2002)

**Ecological Effects**

Ecological effects from returning adult hatchery-origin fish include redd superimposition, competition for spawning grounds, and contribution of marine derived nutrients. Predation by the returning adult hatchery-origin fish is not likely to be an ecological effect because these adult fish cease to eat upon freshwater entry.

In Table 13 below, the average number of fish from releases out of the Wells Hatchery that have strayed to other basins is summarized. While we do not have data for the proposed hatchery program, we expect these results to be similar to past releases. These numbers are the number of

hatchery-origin fish that could interact with ESA-listed fish in the recipient basins, as discussed below.

Table 13. Average number of hatchery-origin summer salmon straying into other basins.

| Program | Chelan[1] | Entiat[1] | Hanford Reach[2] | Methow[3] | Okanogan[3] | Wenatchee[3] |
|---|---|---|---|---|---|---|
| Wells | 63 | 8 | (not reported) | 108 | 69 | 4 |

[1] Source: (Hillman et al. 2017)

[2] Source: (Richards and Pearsons 2015)

[3] Source: (Snow et al. 2016)

Spawning site competition and redd superimposition are possible ecological effects between spring Chinook salmon and hatchery-origin summer Chinook salmon. The potential effects of spawning site competition could occur in September when spawning timing of UCR spring and summer Chinook salmon runs could briefly overlap (Table 12). However, the likelihood of spatial overlap is minimal because spring Chinook salmon tend to spawn farther upstream than summer Chinook salmon (e.g., Snow et al. (2016), Hillman et al. (2016)).

Even though summer and spring Chinook salmon may overlap spatially in some tributary mainstems, the likelihood of redd superimposition appears to be low even in target areas. In the Wenatchee River, which is a target area of the previously consulted on Wenatchee program (NMFS 2017b) redd superimposition of spring Chinook salmon redds by summer Chinook salmon from the Wenatchee summer Chinook program were observed to be very limited, typically 2 or 3 per year (Willard 2017), compared to the average of 48 spring Chinook salmon redds observed in the mainstem Wenatchee River (Hillman et al. 2016). Because this tributary is a spawning ground for both natural-origin and hatchery-origin summer Chinook salmon, only a subset of the observed redd superimposition is a result of redd superimposition by the hatchery-origin fish from the Wenatchee summer Chinook salmon program. Because the Wenatchee summer Chinook hatchery program fish return to the Wenatchee River and the fish from the Wells summer Chinook hatchery program are intended to return to the mainstem Columbia (with a few exceptions, Table 13) we do not expect any fish from this new program to superimpose on spring Chinook salmon redds in the tributaries where spring Chinook salmon spawn. We, therefore, conclude that the likelihood of redd superimposition on UCR spring Chinook salmon by hatchery-origin summer Chinook salmon from the Wells summer Chinook salmon program is low, and the adverse effects, therefore, minimal.

Spawning site competition and redd superimposition by summer Chinook salmon as a result of the Proposed Action are not likely to affect steelhead because steelhead spawning and emergence occur before summer Chinook salmon spawn.

Because the average total numbers of strays from all programs into other basins are small and because the likelihood of competition or redd superimposition is minimal to none, the strays

from this hatchery program are unlikely to have any detectable ecological effects on any of the naturally spawning ESA-listed species.

Hatchery fish contribute marine-derived nutrients to the ecosystem in the Upper Columbia River. This program does not intend for returning adults to spawn naturally. Fish are removed through harvest and by the Wells Hatchery volunteer channel for broodstock, surplus, and gene flow management. Fish that are not removed would contribute marine derived nutrients to the ecological system.

**Adult Collection Facilities**

*Negligible:* While broodstock collection for these programs target summer Chinook salmon, ESA-listed spring Chinook salmon or steelhead could be encountered incidentally to the broodstock collection; these encountered spring Chinook salmon or steelhead are handled, but these encounters do not lead to mortality. Most of the encounters of UCR spring Chinook salmon during broodstock collection for summer Chinook salmon occur concurrently with RM&E associated with the spring Chinook salmon. Broodstock collection for this program occurs prior to the arrival of most of the steelhead run, limiting the number of steelhead encountered. Thus, only a small number of spring Chinook salmon and steelhead are expected to be encountered in addition to encounters analyzed in other opinions. Table 14 summarizes where the effects have already been considered in other opinions.

Table 14. Broodstock collection for summer Chinook salmon and associated biological opinions where effects on listed species have been already analyzed.

| Program | Collection Location | Collection Duration | Spring Chinook Salmon Analysis | Summer Steelhead Analysis |
|---|---|---|---|---|
| Wells Hatchery | Wells Hatchery/Dam | July 1-August 28 | NMFS (2016b) | NMFS (2017f) |

Operators use visual inspection combined with genetic samples from spring Chinook salmon to verify that the correct runs are used in broodstock. In addition, summer Chinook predominantly return to the volunteer channel in Wells Hatchery whereas spring Chinook tend to return through the fish ladders in the Wells Dam. Fish are collected at each of these locations, accordingly.

### 2.5.2.3. Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migratory corridor, estuary, and ocean

NMFS also analyzes the potential for competition and predation when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas and migratory corridors. Because the fish released under the Proposed Action are likely to affect natural-origin fish as they emigrate, the effects analysis here includes the distance from release to the confluence of the Snake River. This factor can have effects on the productivity VSP parameter (Section 2.5) of the natural population. The effect of this factor on all listed salmonid species is negative. It is important to keep in mind that some results of the model below are an

overestimation of interaction and predation values for those fish that also includes non-listed species (e.g., summer Chinook salmon in Upper Columbia River) because of uncertainty in the data used for the model run. While we cannot characterize or quantify the amount of overestimation, this approach is a precautionary approach because it assumes the maximum possible effect on listed species.

**Hatchery release competition and predation effects**

In reviewing competition and predation effects in the mainstem Columbia River, NMFS used the PCD Risk model of Pearsons and Busack (Pearsons and Busack 2012), to quantify the potential number of natural-origin salmon and steelhead juveniles lost to competition and predation from the release of hatchery-origin juveniles. Although model logic is still largely as described in the Pearsons and Busack 2012 paper the PCD Risk model has undergone considerable modification since then to increase supportability and reliability. Notably, the current version no longer operates in a Windows environment and no longer has a probabilistic mode. We also further refined the model by allowing for multiple hatchery release groups of the same species to be included in a single run. The one modification to the logic was a 2018 elimination of competition equivalents and replacement of the disease function with a delayed mortality parameter. The rationale behind these changes was to make the model more realistic; competition rarely directly results in death in the model because it takes many competitive interactions to suffer enough weight loss to kill a fish. Weight loss is how adverse competitive interactions are captured in the model. However, fish that are competed with and suffer some degree of weight loss are likely more vulnerable to mortality from other factors such as disease. Now, at the end of each run, the competitive impacts for each fish are assessed, and the fish has a probability of delayed mortality based on the competitive impacts. This function will be subject to refinement based on research. For now, the probability of delayed mortality is equal to the proportion of a fish's weight loss. For example, if a fish has lost 10% of its body weight due to competition and a 50% weight loss kills a fish, then it has a 20% probability of delayed death, (0.2 = 0.1/0.5). Parameter values used in the model runs are shown in Table 15 -Table 17.

For our model runs, we assumed a 100 percent population overlap between hatchery fish and all natural-origin species present. Hatchery summer Chinook salmon are volitionally released in mid-May. These releases may overlap with natural-origin coho; sockeye; spring, summer, and fall Chinook salmon; and steelhead in the Action Area. However, our analysis is limited to assessing effects on listed species, and this limits overlap of those species to certain areas. We acknowledge that a 100-percent population overlap in microhabitats is likely an overestimation.

The model was run from release site at the Wells Hatchery to the confluence of the Snake River. The following explains the caveats regarding each step of this model run from release to the confluence of the Snake River:

- Travel (residence) time was calculated using mean miles per day and distance from point A to point B. The reported value is the arithmetic mean travel days over the years 2009 to 2019 (Tonseth 2020).

- Survival information to the confluence of the Snake River does not exist (no PIT detection array in this location) so we used the ten year arithmetic mean of survival data from release (Wells Hatchery) to Rocky Reach and release to McNary Dam in the years 2009 to 2019 as a proxy (Tonseth 2020).
- Water temperatures at the release sites were used in model runs.
- Model runs account for hatchery fish predation and competition effects on natural-origin age-1 Spring Chinook salmon and age-2 steelhead because rearing fish (age-0 Spring Chinook salmon and age-1 steelhead) are not present in substantial numbers in the mainstem Columbia River. The negligible amount of age-1 steelhead that may be present would largely be included in the age-2 steelhead class (Tonseth 2020).

Table 15. Parameters from the PCD Risk model that are the same across all programs.

| Parameter | Value[1] |
|---|---|
| Habitat complexity | 0.1 |
| Population overlap | 1.0 |
| Habitat segregation | 0.3 for Chinook salmon;<br>0.6 for all other species |
| Dominance mode | 3 |
| Piscivory | 0 for all species interacting with subyearling summer Chinook salmon |
| Maximum encounters per day | 3 |
| Predator:prey length ratio for predation | 0.25[2] |

[1] All values from HETT (2014) unless otherwise noted.

[2] Daly et al. (2014)

Table 16. Age and size of listed natural-origin salmon and steelhead encountered by juvenile hatchery fish after release.

| Species | Age Class | Size in mm (SD) | Source |
|---|---|---|---|
| Chinook salmon | 0 | 38 (4) | HETT (2014) |
| | 1 | 98 (4) | HETT (2014) |
| Steelhead | 1 | 126 (24) | HETT (2014) |
| | 2 | 170 (24) | HETT (2014) |

Table 17. Hatchery fish parameter values for the PCD Risk model run from release of fish to the confluence of the Snake River.

| Program | Release Site | Release Number | Size in mm (SD) at release | Survival Rates to Snake confluence (mean)[1] | Travel (residence) Time (mean days) from release to confluence of the Snake River[2] | Temp. at release[3] (°C) |
|---|---|---|---|---|---|---|
| Wells summer Chinook salmon (subyearlings) | Columbia River (RM 515) | 1,000,000 | 103 (20) | 0.43 | 31.01 | 9.7 |

[1] Survival information to the confluence of the Snake River does not exist (no array) so we found the arithmetic mean of survival data from release (Wells Hatchery) to Rocky Reach and release to McNary Dam in the years 2009 to 2019 (Tonseth 2020)

[2] Travel time was estimated by dividing the number of miles between Wells Dam and the confluence of the Snake River by the number of miles per day between Wells and McNary dams.

[3] Data from http://www.cbr.washington.edu/dart/query/river_graph_text; access date August 16, 2017. 10 year average (2007-2016) of temperature (WQM).

We conducted model runs with natural-origin fish numbers at the point where all possible hatchery-origin fish interactions are exhausted at the end of each day. It is possible that in doing this, we ran the models with natural-origin juvenile abundances that exceed actual numbers available. Using natural-origin juvenile numbers at the point where all possible hatchery-origin fish interactions are exhausted at the end of each day allows us to estimate worst-case impacts on listed natural-origin fish. To ensure the effects due to competition and predation are within our model estimates, we will continue to monitor median travel times from release to the confluence of the Snake River on an annual basis (using a 5-year rolling median) compared to the values used in our analyses (see Table 17). The resulting juveniles lost from release to the confluence of the Snake River for all natural-origin species are summarized in Table 18. Using the smolt-to-adult survival rate (SAR) representative of each species, these lost juveniles equate to 32 adult Spring Chinook salmon and 1 adult steelhead (Table 18) from release to the confluence of the Snake River.

Table 18. Maximum numbers of juvenile natural-origin salmon and steelhead lost to competition (C) from hatchery-origin summer Chinook salmon from the Proposed Action for model runs from release to the Confluence of the Snake River. There are no losses due to predation (P) because the hatchery subyearling summer Chinook salmon are too small to eat age-one Chinook

in the mainstem Columbia at this point in time, and assumed no predation occurs on steelhead or sockeye salmon from subyearling Chinook salmon in the mainstem Columbia (HETT 2014).

| Program | Release Site | Chinook Salmon[1] | Steelhead[2] |
|---|---|---|---|
| | | C[3] | C[3] |
| Wells summer Chinook salmon (subyearlings) | Columbia River (RM 515) | 8,778 | 15 |
| SAR[4] | | 0.0037 | 0.011 |
| Adult Equivalents | | 32 | 1 |

[1] The Chinook salmon lost here includes age-1 fish from release site (Wells Hatchery) to the confluence of the Snake River.

[2] The steelhead lost here includes age-2 fish from release site (Wells Hatchery) to the confluence of the Snake River.

[3] Competition, as used here, is the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body-weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This is not reality, but does provide a maximum mortality estimate using these parameter values.

[4] SAR for Chinook salmon (average of: Grant County PUD et al. 2009b; NMFS 2016b) and steelhead (NMFS 2017f).

Similar to the use of models for biological systems elsewhere, this model cannot possibly account for all the variables that could influence competition and predation of hatchery juveniles on natural juveniles. For example, the model assumes that if a hatchery fish is piscivorous and stomach capacity allows the fish to consume prey it will be natural-origin prey. The reality is hatchery-origin fish could choose to eat a wide variety of invertebrates, other fish species (e.g., shad, minnows), and other hatchery-origin fish in addition to natural-origin smolts. However, we believe that with this model we are estimating, to the best of our ability, a worst-case estimate for the effects on natural-origin juveniles.

While these numbers represent the maximum potential effect from the Proposed Action, these ecological interactions also occur between natural-origin species; thus, the effects attributable to the Proposed Action is only that portion that exceeds the natural level of ecological interactions. Because the Chinook salmon lost to ecological effects between release and the confluence of the Snake River includes both listed and non-listed fish, only a portion of the lost adult Chinook salmon equivalents are likely to be listed. However, our analysis assumes that all Chinook salmon lost are listed in order to represent an absolute maximum total (and in the absence of more precise data). We also assume that the effects on each population within each ESU is proportional to their ESU composition. For example if a single population represents 5 percent of the natural-origin adults in the ESU, then the loss our model predicts would be some percentage of the 5 percent contribution of that population to the ESU.

To understand the potential effect on the UCR Spring Chinook salmon ESU and Steelhead DPS, we calculated the likely percentage of adults that would be lost from competition and predation from each ESU and DPS. In other words, we divided the total amount of adult equivalents lost by the most recent five year average natural-origin escapement of the ESU or DPS (ODFW and WDFW 2016) and multiplied this by one hundred. These would equate to a potential loss of <1 percent of the potential adult return from competition and predation during the adult life stage (Table 19) Based on the assumptions used in NMFS' simulations, even before taking into account the very conservative nature of these assumptions, it appears that ecological impacts from the release of the 1 million hatchery-origin subyearlings included in this Proposed Action is negligible.

Table 19. Maximum total ESA-listed natural-origin adult equivalents lost through competition and predation with juvenile hatchery fish by ESU/DPS compared to returning adults of respective ESU/DPS.

| **Listed Species (ESU/DPS)** | **Total adult returns** | **Total lost adult equivalents to competition and predation** | **Percentage of Lost Adults to Total Adults at confluence of the Snake River** |
|---|---|---|---|
| UCR Spring Chinook Salmon ESU | 5,064[1] | 32 | 0.63 |
| UCR Steelhead DPS | 6,929[2] | 1 | 0.01 |

[1] This number was obtained by taking the average number of wild adult returns to the Columbia River from 2011 to 2015 from Table 8 of ODFW and WDFW (2016).

[2] To obtain these numbers, we summed the total wild summer steelhead returns (Table 6 of WDFW and ODFW 2017) and total wild winter steelhead returns (Table 11 of ODFW and WDFW 2016) for 2011 to 2015, then applied the proportions of DPS obtained from Zabel (2013); Zabel (2014a); Zabel (2014b); Zabel (2015); Zabel (2017), described above.

Another effect on natural-origin fish can result from released fish that residualize in a tributary. Residual hatchery fish are those fish that do not emigrate following release from the hatchery. These fish have the potential to compete with and prey on natural-origin juvenile fish for a longer period of time relative to migrants. Residuals are not explicitly accounted for in our model at this time. The ecological impacts of hatchery fish residualizing are likely to occur in the tributaries, where natural-origin fish are rearing because residual fish would compete with or prey on rearing fish. Therefore, residuals from programs that release into mainstem Columbia River (i.e., Wells Hatchery summer Chinook program) would not be expected to have any effect if they stay in mainstem Columbia River. However, if they migrate to a tributary, they could also have ecological effects on natural-origin fish. Because natural-origin summer Chinook salmon migrate out as subyearlings, the risk that subyearlings released through the hatchery program remain to residualize and affect ESA-listed species is negligible.

Because residuals are likely to occur as a subset of early mature fish, only a subset, if any, of these hatchery fish would have residualized, though the extent is unknown. In addition, residuals that linger around the release site may not encounter listed juvenile fish because the natural-

origin juvenile rearing occurs in the tributary(ies), upstream and in other rivers than the release site.

Applicants have a Proposed Action that is expected to minimize their ecological impacts, and continue to improve their hatchery rearing practice to minimize early maturation. For example, subyearlings are reared on surface water that is at ambient natural temperatures before release. The fish are grown to a size target designed to balance survival and residualism. The release timing has been adjusted to maximize survival from release to adult, and it is possible that a component of this survival is gained by reduced residualism. Based on observations from similar programs, NMFS expects that no more than 5 percent of program fish from each release group should be observed as having the potential to residualize, using a running five-year average beginning with the 2020 release.

**Naturally-produced progeny competition**

Naturally spawning hatchery-origin Chinook salmon are likely to be less efficient at reproduction than their natural-origin counterparts (Christie et al. 2014), but the progeny of such hatchery-origin spawners are likely to make up a sizable portion of the juvenile fish population given the totality of hatchery releases. Therefore, added production could result in a density-dependent response of decreasing growth/mortality, earlier migration due to high densities, and potential exceedance of habitat capacity. This is unlikely because the fish are not released in the tributaries; therefore, since they are not homing to tributaries, only a small number of adults from this program are expected stray into tributaries to potentially spawn successfully. However, ecological impacts on listed species may increase in the future if the summer Chinook salmon populations grow.

Because summer Chinook salmon historically coexisted in substantial numbers with listed salmon and steelhead in the Upper Columbia Basin, it follows that there must have been adequate passage and habitat to allow both species to be productive and abundant. It does not follow automatically, however, that the historical situation can be restored under present-day conditions. In the short-term, we do not believe current densities are limiting natural-origin salmon and steelhead production. NMFS expects that the monitoring efforts would detect negative impacts before they reach problematic levels, and we include language in the Incidental Take Statement (ITS) (Section 2.9) to ensure that appropriate monitoring takes place.

**Disease**

The risk of pathogen transmission to natural-origin salmon and steelhead is likely negligible for this hatchery program. This is because no detections of exotic pathogens have occurred in the last three years at a similar program out of the Wells Hatchery. Furthermore, epidemics have all been caused by endemic pathogens with available treatments (Table 20). Diseases that could be caused by pathogens outlined in Table 20 were treated accordingly (e.g., medicated feed, formalin) (WDFW 2017b).

Table 20. Pathogens detected in summer Chinook salmon reared in a similar program out of the Wells Hatchery.

| **Program** | | **Pathogen Detected** | | |
|---|---|---|---|---|
| | | **2017** | **2018** | **2019** |
| Wells Summer Chinook | Bacteria | *Flavobacterium columnare* | *Flavobacterium columnare* | *Flavobacterium columnare* |
| | | *Renibacterium salmoninarum* | *Flavobacterium branchiophilum* | *Flavobacterium psychrophilum* |
| | | | *Pseudomonas fluorescens* | *Renibacterium salmoninarum* |
| | Protozoa | *Ichthyophthirius multifiliis* | *Ichthyophthirius multifiliis* | *Ichthyophthirius multifiliis* |
| | | *Chilodonella* sp. | *Ichthyobodo necator* | |
| | | *Ichthyobodo necator* | *Tetrahymena* sp. | *Ichthyobodo necator* |
| | Nematodes | *N/A* | *N/A* | *Anisakiasis* |
| | Copepods | *Salmincola* sp. | *Salmincola* sp. | *Salmincola* sp. |
| | Fungi | *N/A* | *Phoma herbarum* | *Phoma herbarum* |
| | Water molds | *Saprolegnia parasitica* | *Saprolegnia parasitica* | *Saprolegnia parasitica* |

Douglas County PUD has endeavored to mitigate fish loss and morbidity through therapeutic intervention when appropriate. FDA-approved chemicals, such as formalin, have been used successfully to treat external water mold and protozoan infestations. Infections caused by bacteria, namely those in the genus Flavobacterium, have been managed with Diquat Reward™ (an herbicide permitted for aquaculture use through a special investigational new animal drug [INAD] study) or florfenicol medicated feed. Other conditions that are caused by developmental abnormalities, adverse environmental conditions, nutritional deficiencies, or pathogens without proven efficacious remedies, are approached with emphasis on prevention (i.e. changes in fish culture practices) or increased biosecurity standards if the ailment is believed to be caused by an infectious agent. Control strategies have been largely successful in reducing fish morbidity, mortality, and the spread of disease, with few exceptions. The most significant fish health event concerning Chinook at Wells Hatchery within the last few years occurred in October 2017. Summer Chinook adults (broodstock) were afflicted with columnaris disease for the first time in the hatchery's known history, and the acute and virulent nature of the infection caused substantial pre-spawning mortality. Other hatcheries in the region experienced a similar event that year. This disease is now considered enzootic to the upper Columbia River and is largely attributed to changing river conditions. Today, returning adults are screened for lesions before entering the hatchery and treated early if clinical symptoms are observed; this has proven to be an effective approach. Wells Hatchery aspires to maintain a high standard of fish culture and disease management practices. Thus, NMFS believes the risk of pathogen transmission to wild fish from hatchery fish and amplification of pathogens in the natural environment is low.

#### 2.5.2.4. Factor 4. Research, monitoring, and evaluation that exists because of the hatchery program

There are no direct sampling efforts made for summer Chinook salmon for the Wells Hatchery programs. Therefore, we conclude that ESA-listed species are not likely to be affected.

#### 2.5.2.5. Factor 5. Construction, operation, and maintenance of facilities that exist because of the hatchery program

Best available information indicates that most hatchery facility operations have no effect on ESA-listed species. The analysis here focuses on the effects on Upper Columbia River spring Chinook salmon and steelhead because other ESA-listed species are not present in areas where hatchery facility operations could cause an effect.

As described in Table 21, the operation of this facility has been analyzed in a previous consultation (NMFS 2017f) Please refer to this consultation for more information regarding facility water withdrawal, effluent, and discharge analyses. In addition, this facility is appropriately screened and in compliance with NMFS criteria for their intake pipes and is operated under an NPDES permit Table 5.

**Table 21. Program facility and water use**

| Program | Facility | Surface Water (cfs) | Ground Water (cfs) | Water Source | Water Diversion Distance | Discharge Location |
|---|---|---|---|---|---|---|
| Wells Hatchery Summer/Fall Chinook Salmon | Wells Hatchery[1] | 150 | 38 | Columbia River | ~650 ft. | Columbia River |

[1]The operation of Wells Hatchery was analyzed in NMFS (2017f).

As previously described in (NMFS 2017f), this facility is not likely to adversely affect ESA-listed salmonids.

#### 2.5.2.6. Factor 6. Fisheries that exist because of the hatchery program

There are no fisheries that exist because of the Proposed Action. The effects of fisheries that may impact fish produced by this program is described in Section 2.4.4.

### 2.6. Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area of the Federal action subject to consultation (50 CFR 402.02). For the purpose of this analysis, the Action Area is that part of the Columbia River Basin described in Section 1.4. To the extent ongoing activities have occurred in the past and are currently occurring, their effects are included in the baseline (whether they are Federal, state, tribal or private). This includes the impacts of other hatchery programs in the Action Area that were included in the environmental baseline (Section 2.4). To the extent those same activities are reasonably certain to occur in the future (and are tribal, state

or private), their future effects are included in the cumulative effects analysis. This is the case even if the ongoing tribal, state or private activities may become the subject of section 10(a)(1)(B) incidental take permits in the future until an opinion for the take permit has been issued.

State, tribal, and local governments have developed plans and initiatives to benefit listed species and these plans must be implemented and sustained in a comprehensive manner for NMFS to consider them "reasonably foreseeable" in its analysis of cumulative effects. Recovery Plans for various species in the Columbia River Basin (NMFS 2009; NMFS 2013c; NMFS 2015a; NMFS 2015b; NMFS 2016c; NMFS and ODFW 2011; UCSRB 2007) are such plans and they describe, in detail, the on-going and proposed Federal, state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon and steelhead in the Columbia River Basin. It is acknowledged, however, that such future state, tribal, and local government actions would likely be in the form of legislation, administrative rules, or policy initiatives, and land-use and other types of permits, and that government actions are subject to political, legislative, and fiscal uncertainties.

A full discussion of cumulative effects can also be found in the FCRPS Biological Opinion (NMFS 2008c), the *U.S. v Oregon* Biological Opinion (NMFS 2018), the Mitchell Act Biological Opinion (NMFS 2017a), and the Biological Opinion for Four Summer/Fall Chinook Salmon and Two Fall Chinook Salmon Hatchery Programs in the Upper Columbia River Basin (NMFS 2017b), many of which are relevant to this Action Area. These include effects from hydropower operations, harmful land-use practices, fisheries, and hatchery operations on ESA listed salmon and steelhead. These effects may interfere with salmon and steelhead passage/migration, food web interactions, ecological interactions, genetics, and spawning as well as abiotic factors like water quantity/quality, temperature, total dissolved oxygen, and sediment transport. Downstream ecological interactions have been modeled in the Biological Opinion on the Mitchell Act Funded Hatchery programs (NMFS 2017e) as well as the *United States v Oregon* Biological Opinion (NMFS 2018), which helps support our idea that there would unlikely be discernible effects from this program on EA listed salmon and steelhead downstream of the Snake River. It should be noted that the actions in these Biological Opinions are included in the Environmental Baseline Section 2.4.

The cumulative impacts from these programs contribute to the total impacts from hatcheries in the entire Columbia River Basin, which is noted in the Mitchell Act Biological Opinion (NMFS 2017a). Between those programs which have already undergone consultation and those for which consultation is underway, it is likely (though uncertain for ongoing consultations) that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the Columbia River Basin will change over time. Although adverse effects will continue, these changes are likely to reduce effects such as competition and predation on natural-origin salmon and steelhead compared to current levels, especially for those species that are listed under the ESA. This is because all salmon and steelhead hatchery programs funded and operated by non-federal agencies and tribes in the Columbia River Basin have had to undergo review under the ESA to ensure that listed species are not jeopardized and that "take" under the ESA from salmon and steelhead hatchery programs is minimized or avoided. Although adverse effects on natural-

origin salmon and steelhead will likely not be completely eliminated, effects would be expected to decrease from current levels over time to the extent that hatchery programs are reviewed and approved by NMFS under the ESA. Where needed, reductions in effects on listed salmon and steelhead are likely to occur (and have been occurring) through changes in:

- Hatchery monitoring information and best available science
- Times and locations of fish releases to reduce risks of competition and predation
- Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives
- Incorporation of new research results and improved best management practices for hatchery operations
- More accurate estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management approaches

In addition to the effects described above, climate change may increase temperatures, decrease snowpack, shift seasonal hydrology, and increase the frequency of wildfires. We may reasonably expect these effects to alter the physiology, stream flow patterns, and food webs of salmon and steelhead. Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the Action Area. However, it is difficult, if not impossible, to distinguish between the Action Area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant past, present and future climate-related environmental effects in the Action Area are described together in the environmental baseline section.

These potential changes to hatchery operations across the region combined with the Proposed Action result in a net improvement over current conditions. While the hatchery programs around the basin, and under review here as well, lead to negative impacts to listed salmonid species as described above, when the beneficial changes to hatchery practices are also combined with the potential negative impacts from these hatchery programs and the rest of the operations in the Columbia River basin, a net beneficial result is expected as hatchery practices continue to improve and to reduce their negative impacts.

## 2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Action. In this section, NMFS adds the effects of the Proposed Action (Section 2.4.2) to the environmental baseline (2.3) and to cumulative effects (2.5) to formulate the agency's opinion as to whether the Proposed Action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat. This assessment is made in full consideration of the status of the species and critical habitat and the status and role of the affected population(s) in recovery (Sections 2.2.1, 2.2.2, and 2.2.3).

In assessing the overall risk of the Proposed Action on each species, NMFS considers the risks of each factor discussed in Section 2.4.2., above, in combination, considering their potential additive effects with each other and with other actions in the area (environmental baseline and cumulative effects). This combination serves to translate the positive and negative effects posed by the Proposed Action into a determination as to whether the Proposed Action as a whole would appreciably reduce the likelihood of survival and recovery of the listed species and their designated critical habitat.

### 2.7.1. UCR Spring Chinook Salmon ESU

Best available information indicates that the UCR Spring Chinook Salmon ESU is at high risk and remains Endangered (NWFSC 2015). After taking into account the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the effects of the Proposed Action will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU.

Our environmental baseline analysis considers the effects of hydropower, changes in habitat (both beneficial and adverse), fisheries, and hatcheries on these ESUs. Although all may have contributed to the listing of these ESUs and continue to constitute limiting factors in species recovery, all factors have also seen improvements in the way they are managed/operated. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve for natural populations).

The effects of our Proposed Action on this ESU beyond those included in the baseline are limited to ecological effects. Adverse ecological effects on adults are small because of the differences in spatial and temporal overlap between UCR spring Chinook salmon and the hatchery-origin adults. However, natural-origin juveniles may potentially undergo larger effects because of the overlap in outmigration timing with the hatchery-origin juveniles from the proposed program. Our analysis showed that the impacts of this program could equate to up to a loss of 32 Chinook salmon adult equivalents from the ESU, which constitutes 0.63 percent of returning adults from this ESU at the mouth of the Columbia River. Because the model differentiates fish by size and not by run timing, these 32 adult equivalents includes all Chinook juveniles within a size range, and thus could also include unlisted summer or fall Chinook salmon as well (i.e., not all 32 would necessarily be UCR spring Chinook).

Assuming the worst-case scenario that all 32 adult equivalents would be UCR spring Chinook, the total impacts on the UCR Spring Chinook ESU as a result of the Proposed Action would be the loss of an estimated maximum of 0.63 percent of adult equivalents from ecological interactions during juvenile outmigration. The effect of these losses would be to reduce the abundance and productivity of the ESU. As described in Section 2.2.1.2, above, all three remaining populations in this ESU are at High risk, while the Okanogan population is extirpated. For each of the High-risk populations, current abundances are well below minimum abundance thresholds, and productivities are well below replacement (1.0) with the exception of the Entiat

River population (Table 7). NMFS expects that, because the impacts of the Proposed Action on this ESU would accrue during downstream migration, the effects of the Proposed Action would apply proportionally to the three populations. Therefore, each population would be expected to lose a maximum 0.21 percent of the outmigrating juvenile abundance as a result of the Proposed Action. This 0.21-percent loss would not be large enough to have a marked effect on the abundance or productivity of any of the populations. In addition, as described in Section 2.5.2.3, the actual predation and competition effects may be smaller to an unknown extent than those modeled, though even the conservative assessment of effects utilized in this Opinion does not suggest an extensive risk to the species. Taken together, NMFS has determined that the level of impact on abundance and, therefore, productivity, of the Proposed Action would not appreciably reduce the likelihood of survival and recovery of this ESU.

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plans for the ESU describe the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed salmon. Such actions are improving habitat conditions, and hatchery and harvest practices to protect listed salmon ESU. NMFS expects this trend to continue and could lead to increases in abundance, productivity, spatial structure and diversity.

After taking into account the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the small effects of the Proposed Action on abundance, productivity, spatial structure, and diversity, will not appreciably reduce the likelihood of survival and recovery of this ESA-listed ESU in the wild.

### 2.7.2. UCR Steelhead DPS

Best available information indicates that the UCR Steelhead DPS is at high risk and remains at threatened status (Ford et al. 2011). Ford et al. (2011) determined that all populations remain below minimum natural-origin abundance thresholds. In addition, the biological review team identified the lack of direct data on spawning escapements and pHOS in the individual population tributaries as a key uncertainty, rendering quantitative assessment of viability for the DPS difficult (Ford 2011). Still, after taking into account the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the effects of the Proposed Action will not appreciably reduce the likelihood of survival and recovery of the ESA-listed DPS in the wild.

Our environmental baseline analysis considers the effects of hydropower, changes in habitat (both beneficial and adverse), fisheries, and hatcheries on this DPS. Although all may have contributed to the listing, all factors have also seen improvements in the way they are managed/operated. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects (e.g., through hatcheries serving as a genetic reserve for natural populations).

The effects of our Proposed Action on this DPS beyond those included in the baseline are limited to ecological effects. No adverse ecological effects on adults are expected because of the differences in spatial and temporal overlap between UCR steelhead and the hatchery-origin adults returning from the proposed program. However, natural-origin juveniles may potentially experience a negative effect because of the overlap in outmigration timing with the hatchery-origin juveniles from the proposed program. Our analysis showed that the impacts of this program equates to a loss of 1 steelhead adult equivalents from the DPS, which constitutes 0.01 percent of returning adults from this DPS at the mouth of the Columbia River.

The total impacts on the UCR Steelhead DPS as a result of the Proposed Action would be the loss of estimated 0.01 percent of adult equivalents from ecological interactions during juvenile outmigration. The effect of these losses would be to reduce the abundance and productivity of the DPS. As described in Section 2.2.1.2, above, three of the four populations in this DPS are at High risk, while the Wenatchee population is rated Maintained. For each of the High-risk populations, current abundances are well below minimum abundance thresholds, and productivities are well below replacement (1.0) (Table 8). NMFS expects that, because the impacts of the Proposed Action on this DPS would accrue during downstream migration, the effects of the Proposed Action would apply proportionally to the four populations. Therefore, each population would be expected to lose 0.0025 percent of the outmigrating juvenile abundance as a result of the Proposed Action. This 0.0025 percent loss would not be large enough to have a marked effect on the abundance or productivity of any of the populations. In addition, as described in Section 2.5.2.3, the actual predation and competition effects may be smaller to an unknown extent than those modeled, though even the conservative assessment of effects utilized in this Opinion does not suggest an extensive risk to the species. Taken together, NMFS has determined that the level of impact on abundance and, therefore, productivity, of the Proposed Action would not appreciably reduce the likelihood of survival and recovery of this DPS.

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plan for this DPS describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed steelhead. Such actions are improving habitat conditions, and hatchery and harvest practices to protect the listed steelhead DPS. NMFS expects this trend to continue and could lead to increases in abundance, productivity, spatial structure and diversity.

After taking into account the current viability status of these species, the Environmental Baseline, and other pertinent cumulative effects, including any anticipated Federal, state, or private projects, NMFS concludes that the small effects of the Proposed Action on abundance, productivity, spatial structure, and diversity, will not appreciably reduce the likelihood of survival and recovery of this ESA-listed DPS in the wild.

### 2.7.3. Critical Habitat

Only the PBFs for UCR spring Chinook salmon and UCR steelhead may be affected from the Proposed Action. However, the proposed action will not increase the amount of trapping conducted over that which is ongoing for existing programs. The hatchery water diversion and the discharge pose a negligible effect on designated critical habitat for UCR spring Chinook salmon and UCR steelhead in the Action Area (Section 2.5.2.5). Existing hatchery facilities have not contributed to altered channel morphology and stability, reduced and degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity. The operation of the traps and other hatchery facilities may impact only the migration PBFs for UCR spring Chinook salmon and UCR steelhead due to delay at these structures and possible rejection. Moreover, the operation of these facilities will occur whether or not the Proposed Action is implemented, so the proposed hatchery program will not increase the trapping activity. Therefore, the number of natural-origin adults delayed is not expected to increase over current conditions. Thus, there will be very little to no additional impact on the spawning, rearing, and migration PBFs of UCR spring Chinook salmon and UCR steelhead, and will not appreciably diminish the capability of the critical habitat to satisfy the essential requirements of the species.

Climate change may have some effects on critical habitat as discussed in Section 2.4.2. With continued losses in snowpack and increasing water temperatures, it is possible that increases in the density and residence time of fish using cold-water refugia could result in increases in ecological interactions between hatchery and natural-origin fish of all life stages, with unknown, but likely small effects. The continued restoration of habitat may also provide additional refugia for fish. After reviewing the Proposed Action and conducting the effects analysis, NMFS has determined that the Proposed Action will not alter PBFs essential to the conservation of a species or preclude or significantly delay development of such features.

## 2.8. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the Action Area, the effects of the Proposed Action, including effects of the Proposed Action that are likely to persist following expiration of the Proposed Action, and cumulative effects, it is NMFS' biological opinion that the Proposed Action is not likely to jeopardize the continued existence or recovery of any of the ESUs and DPSs listed in the Columbia River Basin (Table 6 and Table 22), or destroy or adversely modify designated critical habitat.

Table 22. Summary of NMFS determination of effects.

| ESA-Listed Species | Is the Action Likely to Adversely Affect Species? | Is the Action Likely to Adversely Affect Critical Habitat? | Is the Action Likely To Jeopardize the Species? | Is the Action Likely To Destroy or Adversely Modify Critical Habitat? |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Upper Columbia River Spring Chinook salmon | Yes | Yes | No | No |
| Upper Columbia River steelhead | Yes | Yes | No | No |

## 2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass[2], harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not prohibited under the ESA, if that action is performed in compliance with the terms and conditions of the ITS.

### 2.9.1. Amount or Extent of Take

**Factor 2: Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities**

Incidental take of UCR spring Chinook and steelhead associated with broodstock collection for this program occurs concurrently with RM&E associated with the spring Chinook salmon. These effects are evaluated in the Biological Opinions on the Methow/Winthrop spring Chinook salmon programs and the amount or extent of incidental take associated with those actions is described there (NMFS 2016b) and the WNFH/Wells Complex steelhead programs (NMFS 2017f).

[2] NMFS recognizes the benefit of providing guidance on the interpretation of the term "harass". As a first step, for use on an interim basis, NMFS will interpret harass in a manner similar to the USFWS regulatory definition for non-captive wildlife: "Create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." NMFS interprets the phrase "significantly disrupt normal behavioral patterns" to mean a change in the animal's behavior (breeding, feeding, sheltering, resting, migrating, etc.) that could reasonably be expected, alone or in concert with other factors, to create or increase the risk of injury to an [ESA-listed] animal when added to the condition of the exposed animal before the disruption occurred. See Weiting (2016) for more information on the interim definition of "harass."

**Factor 3: Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas and the migratory corridor**

Predation and competition (collectively referred to as ecological interactions for the purposes of this opinion) between natural-origin juvenile salmon and steelhead and hatchery summer Chinook salmon smolts could result in take of natural-origin salmon and steelhead. However, it is difficult to quantify this take because ecological interactions cannot be directly or reliably measured and/or observed. Thus, we will quantify the extent of take through ecological effects using two different surrogates, one specifically addressing residualism of hatchery summer Chinook and the second related to how quickly hatchery summer Chinook salmon leave the system.

For residualism, the take surrogate is the percentage of summer Chinook salmon from the yearling release group, used as a proxy for the subyearling release group that are observed to be either parr, precociously maturing, or precociously mature prior to release. This surrogate has a causal link to the amount of take expected from residualism because precocious summer Chinook salmon and parr may residualize after release from the hatchery. This take surrogate covers the take pathway whereby the residual hatchery fish potentially compete with or prey on juvenile natural-origin fish for an extended period of time. NMFS considers, for the purpose of this take surrogate, that no more than 5 percent of program fish from each release group should be observed as having the potential to residualize, using a running five-year average beginning with the 2020 release[3]. The take surrogate can be monitored by either of the following methods: 1) lethal visual assessment that would look for precocially mature fish; or 2) non-lethal visual assessment that would look for precocially mature males and parr (as defined by the unlikelihood of it smolting; i.e., if there is any indication that it would smolt, it would not be considered a parr). For the second method, the nonlethal visual assessments are likely to detect a lower rate of potentially residualizing fish, adding parr to the sampling would lead to a higher detection rate than visually assessing for precocially mature males alone. The take surrogate can be reliably measured and monitored through either methods of visual assessment of the hatchery population and/or migrant fish prior to release, both of which NMFS considers to be an effect method of monitoring.

For ecological effects of competition and predation caused by emigrating hatchery summer Chinook salmon, NMFS applies a take surrogate that relates to the median travel time for hatchery fish to reach the confluence of the Snake River after release. Specifically, the extent of take from interactions between hatchery and natural-origin juvenile salmonids through the estuary are measured as follows: the travel time for emigrating juvenile hatchery Chinook salmon is five days longer than the median value (which equates to 50% of the fish) identified in Table 17 for each program for 3 of the previous 5 years of 5-year running medians. For example, if the 5-year running median of the median value in Table 17 is 20 days, and then the median for the next three of five years for a particular release group is 23 days, this would not exceed the

[3] However, if it is apparent, from numbers observed in years prior to the fifth year, that the average is certain to exceed percent after five years, operators will contact NMFS in the year the likely exceedance is discovered.

take threshold, but if it was 25 (or more) days for three of five years, this would exceed the take threshold. This surrogate has a causal link to the extent of incidental take because, if travel time increases in more years than not, it is a sign that fish are not exiting the Action Area as quickly as expected, and that the recurring increase in time indicates that the issue is not related to a single external factor but to a more fundamental change in migration timing. This threshold can be reliably monitored using emigration estimates from PIT tags, though NMFS expects the operators to develop additional juvenile monitoring techniques during the Proposed Action.

- The proposed action is not expected to result in any single release of smolts in numbers that exceed 110% of the targeted release number identified above through ecological interactions;
- The proposed action is not expected to result in any five-year average calculation of smolt releases that exceed 105% of the applicable targeted release number identified above through ecological interactions;
- The proposed action is not expected to result in any change in release location from the locations identified in the HGMPs for the programs included in the Proposed Action through ecological interactions;
- The proposed action is not expected to result in any change from the planned average size of fish released for each program in the Proposed Action through ecological interactions.

### 2.9.2. Effect of the Take

In Section 2.8, NMFS determined that the level of anticipated take, coupled with other effects of the Proposed Action, is not likely to jeopardize the continued existence of the Upper Columbia River Spring Chinook Salmon ESU, and Upper Columbia River Steelhead DPS or result in the destruction or adverse modification of their designated critical habitat.

### 2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize incidental take. NMFS shall ensure that:

1. The applicants implement the hatchery program and operate the hatchery facilities as described in the Proposed Action (Section 1.2) and in the submitted HGMPs.
2. The applicants provide reports to SFD annually for the hatchery program, and associated RM&E.

### 2.9.4. Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). Action

Agencies have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply, NMFS would consider whether it is necessary to reinitiate consultation.

NMFS shall ensure that:

1a. The applicants implement the Wells Summer Chinook Hatchery Program for Southern Resident Killer Whales program as described in the Proposed Action (Section 1.2) and the submitted HGMP including:

   i. Providing advance notice to NMFS of any change in hatchery program operation that potentially increases the amount or extent of take, or results in an effect of take not previously considered.
   ii. Providing notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion.
   iii. Allowing NMFS to accompany any employee or representative field personnel while they conduct activities covered by their biological opinion.

2. The applicants provide reports to NMFS SFD annually on or before December 31st of the year following data collection for all hatchery programs, and associated RM&E.
   a. All reports/notifications be submitted electronically to the NMFS SFD point of contact for this opinion: Natasha Preston (503) 231-2178, *natasha.preston@noaa.gov*.
   b. Applicants will notify NMFS SFD within 48 hours after exceeding any authorized take, and shall submit a written report detailing why the authorized take was exceeded within two weeks of the event.
   a. Annual reports to SFD for hatchery programs should include:
      i. The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities Hatchery Environment Monitoring Report
         - Number and composition of broodstock, and dates of collection
         - Numbers, pounds, dates, locations, size (and coefficient of variation), and tag/mark information of released fish
         - Survival rates of all life stages (i.e., egg-to-smolt; smolt-to-adult)
         - Disease occurrence at hatcheries
         - Precocious maturation rates prior to release
         - Any problems that may have arisen during hatchery activities
         - Any unforeseen effects on listed fish
      ii. Natural Environmental Monitoring Report
         - The number of returning hatchery and natural-origin adults, including stray information to tributaries

- The number and species of listed fish encountered at each adult collection location, and the number that die
- The contribution of fish from these programs into ESA-listed populations (i.e., Methow River) based on CWT recoveries/PIT tag detections
- Post-release out-of-basin migration timing (median travel time) of juvenile hatchery-origin fish to the confluence of the Snake River.
- Number and species of listed juveniles and adults encountered and the number that die during RM&E activities

### 2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a Proposed Action on listed species or critical habitat (50 CFR 402.02). NMFS has identified no conservation recommendations.

### 2.11. Re-initiation of Consultation

This concludes formal consultation on the approval and implementation of one hatchery program rearing and releasing summer Chinook salmon in the UCR Basin.

As 50 CFR 402.16 states, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

### 2.12. "Not Likely to Adversely Affect" Determinations

The applicable standard to find that a Proposed Action is "not likely to adversely affect" ESA listed species or critical habitat is that all of the effects of the action are expected to be either discountable or insignificant, or the action is expected to be wholly beneficial (USFWS and NMFS 1998). Beneficial effects are contemporaneous positive effects without any adverse effects on the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are extremely unlikely to occur. NMFS has determined that the Proposed Action may affect, but is not likely to adversely affect, the Southern Resident Killer Whale DPS.

### 2.12.1. Southern Resident Killer Whale DPS

The Southern Resident Killer Whales (SRKW; Southern Residents) DPS consist of three pods (J, K, and L) and was listed as endangered on February 16, 2006 (70 FR 69903).

The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008d). Although it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, it is likely that multiple threats are acting together to impact the whales (NMFS 2008d).

Southern Residents inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as northern British Columbia (Hanson et al. 2013; NMFS 2008d). During the spring, summer, and fall, Southern Residents have typically spent a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford et al. 2000; Hanson and Emmons 2010; Krahn et al. 2004). During fall and early winter, SRKWs, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum, coho, and Chinook salmon runs (Ford et al. 2016; Hanson and Emmons 2010; Osborne 1999). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010).

Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska. For example, acoustic recorders have detected SRKWs off Washington coast in all months of the year (Emmons et al. 2019), indicating that the SRKW may be present in Washington coastal waters at nearly any time of year, and in other coastal waters more often than previously believed (Hanson et al. 2017).

As part of a collaborative effort between NWFSC, Cascadia Research Collective and the University of Alaska, satellite-linked tags were deployed on eight male SRKW (three tags on J pod members, two on K pod, and three on L pod) from 2012 to 2016 in Puget Sound or in the coastal waters of Washington and Oregon (Hanson et al. 2017). The tags transmitted multiple locations per day to assess winter movements and occurrences of SRKW (Hanson et al. 2017).

Over the course of the study, the satellite tagging resulted in data range of duration days, from 3 days to 96 days depending on the tag, of monitoring with deployment durations from late December to mid-May. The winter locations of the tagged whales included inland and coastal waters. The inland waters range occurs across the entire Salish Sea, from the northern end of the Strait of Georgia and Puget Sound, and coastal waters from central west coast of Vancouver Island, British Columbia to northern California (Hanson et al. 2017) (Hanson *et al.* 2017). J pod had high use areas in the northern Strait of Georgia and the west entrance to the Strait of Juan de Fuca where they spent approximately 30 percent of their time there. K/L pods occurred almost

exclusively on the continental shelf during December to mid-May, primarily on the Washington coast, with a continuous high use area between Grays Harbor and the Columbia River and off Westport and spending approximately 53 percent of their time there (Hanson et al. 2018).

The only potential effect of the Proposed Action on SRKW is as a result of changes in prey availability. The Proposed Action affects SRKW prey availability in two ways: by producing fish that the whales can feed on, and by reducing (through hatchery-production-related effects described in greater detail elsewhere) the number of natural-origin fish that would ultimately be available to the whales as prey.

Southern Residents consume a variety of fish species but salmon are identified as their primary prey (i.e., a high percentage of prey consumed during spring, summer and fall, from long-term studies of resident killer whale diet; Ford and Ellis 2006; Ford et al. 2016; Hanson et al. 2010). Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling in inland waters from May to September indicate that Southern Residents' diet consists of a high percentage of Chinook, with an overall average of 88% Chinook across the timeframe and monthly proportions as high as >90% Chinook (Ford et al. 2016; Hanson et al. 2010).

Observations of SRKWs overlapping with salmon runs (Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months. Although fewer predation events have been observed and less fecal samples collected in coastal waters, recent data indicate that salmon, and Chinook salmon in particular, remains an important dietary component when the SRKWs occur in outer coastal waters during these timeframes (NMFS 2019). Results of the available prey samples indicate that, as is the case in inland waters, Chinook are the primary species detected in diet samples on the outer coast, although steelhead, chum, lingcod, and halibut were also detected in samples. Despite J pod utilizing much of the Salish Sea – including the Strait of Georgia – in winter months (Hanson et al. 2018), few diet samples have been collected in this region in winter.

The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters from California through Washington included 12 U.S. west coast stocks, and showed that over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpublished data). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90 percent of the 55 diet samples collected for SRKW's in coastal areas (NWFSC unpublished data).

The diet data suggest that SRKWs are consuming mostly larger (*i.e.,* generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Chinook salmon is their primary prey despite the much lower abundance in comparison to other salmonids in some areas and during certain time periods (Ford and Ellis 2006). Factors of potential importance include the species' large size, high fat and energy content, and year-round occurrence in the SRKWs' geographic range. Chinook salmon have the highest value of total energy content compared to other salmonids because of

their larger body size and higher energy density (kcal/kg) (O'Neill et al. 2014). For example, in order for a SRKW to obtain the total energy value of one adult Chinook salmon, they would need to consume approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014).

The Proposed Action may affect SRKWs indirectly by affecting the availability of their primary prey, Chinook salmon. Hatchery-produced Chinook salmon may benefit SRKW by enhancing prey availability, as scarcity of prey has been identified as a threat to SRKW survival and recovery, and hatchery fish often contribute to the salmon stocks consumed by SRKW (Hanson et al. 2010). NMFS and WDFW developed a framework in the Southern Resident Killer Whale Priority Chinook Stocks Report (NOAA and WDFW 2018) to identify Chinook salmon stocks that are important to SRKW. According to this report, the Upper Columbia Summer Chinook Salmon were rated a total score of 3.31 out of 5 points. These total scores are a sum of the following three factors: FACTOR 1- Observed part of SRKW diet (using tissues/scales and fecal samples), FACTOR 2- Consumed during reduced body condition or diversified SRKW diet (using aerial photogrammetry), and FACTOR 3- Degree of spatial and temporal overlap (recent prey mapping to overlap in time and space distribution of all Chinook salmon stocks). It is important to note that this stock was detected in SRKW diet and consumed during a period when there may be a higher likelihood of poor body condition. The primary reason for scoring in the middle of the point system was that the spatial and temporal factor was relatively low for them (Upper Columbia Summer Chinook Salmon have a northerly distribution and do not congregate off of the coast of Washington). A score of 3.31 places this stock in the middle of the Chinook salmon prey list, and qualifies it as priority prey to help aid in the recovery of SRKW.

The annual release of 1,000,000 summer Chinook salmon subyearlings under the Proposed Action could potentially increase the number of Chinook salmon available to the SRKW in coastal waters by 84,000 summer Chinook salmon adults returning annually to the river. These adult survival numbers are calculated by applying the Chinook salmon SARs to the release numbers[4]. Because SARs account for mortality occurring after adult salmon re-enter freshwater, these adult numbers are an underestimation of the available prey for SRKW. NMFS (2017e) estimated that the annual average Chinook salmon abundance from all west coast sources, that could potentially provide prey for SRKW, was approximately 2,035,778 fish. The contribution of summer Chinook salmon to this total from the release of hatchery fish under the Proposed Action is less than 4.13% of the total Chinook salmon abundance.

As described in Section 2.5.2.3, the release of hatchery fish in the Upper Columbia River Basin may affect the natural-origin Chinook salmon production in the basin and reduce the number of natural-origin fish available to SRKW as prey by some small amount because of competition or predation between hatchery-origin and natural-origin juveniles as they emigrate. These losses of juveniles equate to 0.63 percent of returning adults at the mouth within the UCR Spring Chinook salmon ESU, though, as mentioned above, these numbers are likely an overestimate (see section

[4] For the summer Chinook subyearling releases, we used the average SAR% for the Wells subyearling program for brood year 1993–2010, which was 0.084.

2.5.2.3 and Table 19); however, these lost natural-origin fish would be replaced by the hatchery fish, and natural-origin fish numbers may increase over time as the goal of the program is to increase the number of naturally-produced fish spawning in the Upper Columbia River Basin. Based on the current natural-origin abundance in the Upper Columbia River Basin, any increase or decrease in overall natural-origin abundance would not have any discernible effect on the total abundance of Chinook salmon off the west coast. It is unlikely that SRKW would have encountered and consumed all of these fish lost to competition and predation (Table 19) annually because the spatial and temporal distributions of SRKW and Chinook salmon are not entirely overlapping, and there is a low probability that all of these lost natural-origin Chinook would be intercepted by SRKW across their vast range in the absence of the Proposed Action. Therefore, any adverse effect on SRKW as a result of reductions in natural-origin Chinook salmon as prey would be insignificant.

Given the Proposed Action is likely to benefit SRKW with production of hatchery summer Chinook salmon and providing an increase in prey availability, and the effects of the action on the status of listed salmon is small, the release of summer Chinook salmon in the Upper Columbia River under the Proposed Action is not likely to adversely affect the SRKW.

Southern Resident Killer Whale Critical Habitat

Critical habitat in inland waters of Washington was designated on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters of Washington in three specific areas: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. On September 19, 2019 NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,626.6 square miles (mi2) (40,472.7 square kilometers (km2)) of marine waters between the 6.1-meter (m) depth contour and the 200-m depth contour from the U.S. international border with Canada south to Point Sur, California. In the proposed rule (84 FR 49214), NMFS states that the "proposed areas are occupied and contain physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection." The three physical or biological features essential to conservation in the 2006 designated critical habitat were also identified for the six new areas along the U.S. West Coast. In the proposed rule (84 FR 49214), NMFS identified six areas off the U.S. west coast delineated based on SRKW use and the habitat features.

In addition to the direct and indirect effects to the species discussed above, the proposed action affects critical habitat proposed in coastal waters for Southern Resident killer whales. While SRKW critical habitat is not located within the boundaries of the Action Area, the Proposed Action has the potential to affect the quantity and availability of prey within SRKW critical habitat. As discussed above, the annual release of 1,000,000 summer Chinook salmon subyearlings under the Proposed Action could potentially increase the number of Chinook salmon available to the SRKW in coastal waters by 84,000 summer Chinook salmon adults

returning annually to the river. The contribution of summer Chinook salmon to this total from the release of hatchery fish under the Proposed Action is less than 4.13% of the total Chinook salmon abundance. As described in Section 2.5.2.3, the release of hatchery fish in the Upper Columbia River Basin may affect the natural-origin Chinook salmon production in the basin and reduce the number of natural-origin fish available to SRKW as prey by some small amount because of competition or predation between hatchery-origin and natural-origin juveniles as they emigrate. These losses of juveniles equate to 0.63 percent of returning adults at the mouth within the UCR Spring Chinook salmon ESU, though, as mentioned above, these numbers are likely an overestimate (see section 2.5.2.3 and Table 19). Similar to the above arguments above, any adverse effect on SRKW critical habitat as a result of reductions in natural-origin Chinook salmon as prey would be insignificant. We do not anticipate any effects to water quality or passage conditions in proposed critical habitat.

Given the Proposed Action is likely to benefit SRKW critical habitat with production of hatchery summer Chinook salmon and providing an increase in prey availability, and the effects of the action on the status of listed salmon is small, the release of summer Chinook salmon in the Upper Columbia River under the Proposed Action is not likely to adversely affect the SRKW critical habitat.

## 3. Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or Proposed Actions that may adversely affect EFH. The MSA (Section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

### 3.1. Essential Fish Habitat Affected by the Project

The Proposed Action is the implementation of one summer Chinook salmon hatchery program, as described in Section **Error! Reference source not found.**. The Action Area of the Proposed Action includes habitat described as EFH for Chinook and coho salmon (PFMC 2003) within the Upper Columbia River Basin. Because EFH has not been described for steelhead, the analysis is restricted to the effects of the Proposed Action on EFH for Chinook and coho salmon.

As described by PFMC (2003), the freshwater EFH for Chinook and coho salmon has five habitat areas of particular concern (HAPCs): (1) complex channels and floodplain habitat; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine submerged aquatic vegetation. The aspects of EFH that might be affected by the Proposed Action include effects of hatchery operations on ecological interactions on natural-origin Chinook and coho salmon in spawning and rearing areas and adult migration corridors and adult holding habitat, and genetic effects on natural-origin Chinook salmon in spawning areas (primarily addressing HAPC 3).

### 3.2. Adverse Effects on Essential Fish Habitat

The Proposed Action has small effects on the major components of EFH. As described in Section 2.5.2, facilities used for hatchery operations can adversely affect salmon by reducing streamflow, or impeding migration. However, water withdrawals are non-consumptive and small enough in scale that changes in flow within spawning habitat would be undetectable.

The PFMC (2003) recognized concerns regarding the "genetic and ecological interactions of hatchery and wild fish… [which have] been identified as risk factors for wild populations." The

biological opinion describes in considerable detail the impacts hatchery programs might have on natural salmon and steelhead populations (Section 5). Ecological effects of juvenile and adult hatchery-origin fish on natural-origin Chinook salmon are discussed in Sections 2.5.2.2 and 2.5.2.3. Hatchery summer Chinook salmon returning to the Upper Columbia River are not expected to compete for space with spring Chinook or coho salmon because of the usage of different habitats based on fish body size and due to differences in run and spawn timing; spring Chinook salmon spawn in the late summer, and coho salmon spawn in the mid-late fall. In contrast, fish produced by the proposed hatchery program typically spawn from late September to early December (Table 12). Because of this small likelihood of overlap in spawn timing and usage of habitat, the spawning habitat HAPC would not be adversely affected by the Proposed Action.

EFH for Chinook and coho salmon would likely be affected by the Proposed Action through ecological interactions. Some summer Chinook salmon from the program may stray into other rivers (Section 2.5.2.2), but not in numbers that would exceed the carrying capacities of natural production areas, or that would result in increased incidence of disease or predators. Some predation by adult hatchery Chinook salmon on juvenile natural-origin Chinook or coho salmon may occur as summer Chinook salmon hold for a potentially long period of time before spawning. Predation and competition by juvenile hatchery summer Chinook salmon on juvenile natural-origin Chinook or coho salmon is likely small. Our analysis in Section 2.5.2.3 shows that fewer than 32 Chinook salmon adult equivalents and 1 steelhead adult equivalent are likely to be lost to predation and competition with hatchery summer Chinook salmon at the juvenile stage within our Action Area for this consultation.

NMFS has determined that the Proposed Action is likely to adversely affect EFH for Pacific salmon, specifically through small amounts of predation by, and competition with, hatchery fish produced by the Proposed Action.

### 3.3. Essential Fish Habitat Conservation Recommendations

For each of the potential adverse effects by the Proposed Action on EFH for Chinook and coho salmon, NMFS believes that the Proposed Action, as described in the HGMPs and the ITS (Section 2.9), includes the best approaches to avoid or minimize those adverse effects. Thus, NMFS has no additional conservation recommendations specifically for Chinook and coho salmon EFH besides fully implementing the Proposed Action and ITS. However, the Reasonable and Prudent Measures and Terms and Conditions included in the ITS, specifically under RPM #1 and its associated Terms and Conditions, sufficiently address potential EFH effects.

### 3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal action agencies must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation

Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that, in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

### 3.5. Supplemental Consultation

The Federal action agencies must reinitiate EFH consultation with NMFS if the Proposed Action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

## 4. Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) ("Data Quality Act") specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, document compliance with the Data Quality Act, and certifies that this opinion has undergone pre-dissemination review.

### 4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. NMFS has determined, through this ESA section 7 consultation that operation of the summer Chinook salmon hatchery program in the Upper Columbia River as proposed will not jeopardize ESA-listed species and will not destroy or adversely modify designated critical habitat. Therefore, NMFS can issue an ITS. The intended users of this opinion are: the NMFS (authorizing entity); the WDFW (co-manager and funding entity); and the Douglas Public Utility District (operating entity). The scientific community, resource managers, and stakeholders benefit from the consultation through the anticipated increase in summer Chinook salmon in the ocean for southern resident Orca populations and to the Upper Columbia River basin, and through the collection of data indicating the potential effects of the operation on the viability of natural populations of ESA-listed salmonids. This information will improve scientific understanding of hatchery-origin steelhead effects that can be applied broadly within the Pacific Northwest area for managing benefits and risks associated with hatchery operations. This opinion will be posted on NMFS' West Coast Region web site (*http://www.westcoast.fisheries.noaa.gov/*). The format and naming adheres to conventional standards for style.

### 4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, "Security of Automated Information Resources," Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

### 4.3. Objectivity

Information Product Category: Natural Resource Plan

***Standards:*** This consultation and supporting documents are clear, concise, complete, and unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 *et seq*., and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

***Best Available Information:*** This consultation and supporting documents use the best available information, as described in the references section. The analyses in this biological opinion/EFH consultation contain more background on information sources and quality.

***Referencing:*** All supporting materials, information, data, and analyses are properly referenced, consistent with standard scientific referencing style.

***Review Process:*** This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

## 5. Appendix A-Factors Considered When Analyzing Hatchery Effects

NMFS' analysis of the Proposed Action is in terms of effects the Proposed Action would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. The effects, positive and negative, for the two categories of hatchery programs are summarized in Table 23. Generally speaking, effects range from beneficial to negative when programs use local fish[5] for hatchery broodstock, and from negligible to negative when programs do not use local fish for broodstock[6]. Hatchery programs can benefit population viability, but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and at avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. NMFS applies available scientific information, identifies the types of circumstances and conditions that are unique to individual hatchery programs, then refines the range in effects for a specific hatchery program. Analysis of a Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,

(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,

(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migration corridor, estuary, and ocean,

(4) RM&E that exists because of the hatchery program,

(5) operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and

(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

The analysis assigns an effect for each factor from the following categories:

(1) positive or beneficial effect on population viability,

[5] The term "local fish" is defined to mean fish with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU or steelhead DPS (70 FR 37215, June 28, 2005).

[6] Exceptions include restoring extirpated populations and gene banks.

(2) negligible effect on population viability, and

(3) negative effect on population viability.

The effects of hatchery fish on ESU/DPS status will depend on which of the four VSP criteria are currently limiting the ESU/DPS and how the hatchery program affects each of the criteria (NMFS 2005b). The category of effect assigned to a factor is based on an analysis of each factor weighed against each affected population's current risk level for abundance, productivity, spatial structure, and diversity, the role or importance of the affected natural population(s) in ESU or steelhead DPS recovery, the target viability for the affected natural population(s), and the environmental baseline including the factors currently limiting population viability.

**Table 23. An overview of the range of effects on natural population viability parameters from the two categories of hatchery programs.**

| Natural population viability parameter | Hatchery broodstock originate from the local population and are included in the ESU or DPS | Hatchery broodstock originate from a non-local population or from fish that are not included in the same ESU or DPS |
|---|---|---|
| **Productivity** | **Positive to negative effect**<br><br>Hatcheries are unlikely to benefit productivity except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth (i.e., productivity) (NMFS 2004c). | **Negligible to negative effect**<br><br>Productivity is dependent on differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat), the duration and strength of selection in the hatchery, and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect). |
| **Diversity** | **Positive to negative effect**<br><br>Hatcheries can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks and have the potential to increase the effective size of small natural populations. On the other hand, broodstock collection that homogenizes population structure is a threat to population diversity. | **Negligible to negative effect**<br><br>Diversity is dependent on the differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish, the greater the threat) and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect). |
| **Abundance** | **Positive to negative effect**<br><br>Hatchery-origin fish can positively affect the status of an ESU by contributing to the abundance of the natural populations in the ESU (70 FR 37204, June 28, 2005, at 37215). Increased abundance can also increase density dependent effects. | **Negligible to negative effect**<br><br>Abundance is dependent on the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect), handling, RM&E, and facility operation, maintenance and construction effects. |
| **Spatial Structure** | **Positive to negative effect**<br><br>Hatcheries can accelerate re-colonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. "Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005 at 37213). | **Negligible to negative effect**<br><br>Spatial structure is dependent on facility operation, maintenance, and construction effects and the level of isolation achieved by the hatchery program (i.e., the greater the isolation, the closer to a negligible effect). |

## 5.1. Factor 1. The hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock

This factor considers the risk to a natural population from the removal of natural-origin fish for hatchery broodstock. The level of effect for this factor ranges from neutral or negligible to negative.

A primary consideration in analyzing and assigning effects for broodstock collection is the origin and number of fish collected. The analysis considers whether broodstock are of local origin and the biological pros and cons of using ESA-listed fish (natural or hatchery-origin) for hatchery broodstock. It considers the maximum number of fish proposed for collection and the proportion of the donor population tapped to provide hatchery broodstock. "Mining" a natural population to supply hatchery broodstock can reduce population abundance and spatial structure. Also considered here is whether the program "backfills" with fish from outside the local or immediate area. The physical process of collecting hatchery broodstock and the effect of the process on ESA-listed species is considered under Factor 2.

### 5.2. Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

NMFS also analyzes the effects of hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds. The level of effect for this factor ranges from positive to negative.

There are two aspects to this part of the analysis: genetic effects and ecological effects. NMFS generally views genetic effects as detrimental because we believe that artificial breeding and rearing is likely to result in some degree of genetic change and fitness reduction in hatchery fish and in the progeny of naturally spawning hatchery fish relative to desired levels of diversity and productivity for natural populations based on the weight of available scientific information at this time. Hatchery fish can thus pose a risk to diversity and to natural population rebuilding and recovery when they interbreed with fish from natural populations.

However, NMFS recognizes that beneficial effects exist as well, and that the risks just mentioned may be outweighed under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. Conservation hatchery programs may accelerate recovery of a target population by increasing abundance faster than may occur naturally (Waples 1999). Hatchery programs can also be used to create genetic reserves for a population to prevent the loss of its unique traits due to catastrophes (Ford et al. 2011).

NMFS also recognizes there is considerable debate regarding genetic risk. The extent and duration of genetic change and fitness loss and the short- and long-term implications and consequences for different species (i.e., for species with multiple life-history types and species subjected to different hatchery practices and protocols) remain unclear and should be the subject of further scientific investigation. As a result, NMFS believes that hatchery intervention is a legitimate and useful tool to alleviate short-term extinction risk, but otherwise managers should seek to limit interactions between hatchery and natural-origin fish and implement hatchery practices that harmonize conservation with the implementation of treaty Indian fishing rights and other applicable laws and policies (NMFS 2011d).

### 5.2.1. Genetic effects

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. Although there is biological interdependence between them, NMFS considers three major areas of genetic effects of hatchery programs: within-population diversity, outbreeding effects, and hatchery-induced selection. As we have stated above, in most cases, the effects are viewed as risks, but in small populations these effects can sometimes be beneficial, reducing extinction risks.

First, within-population genetic diversity is a general term for the quantity, variety, and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations (described below under outbreeding effects) and is lost primarily due to genetic drift, a random loss of diversity due to population size. The rate of loss is determined by the population's effective population size ($N_e$), which can be considerably smaller than its census size. For a population to maintain genetic diversity reasonably well, the effective size should be in the hundreds (e.g., Lande 1987), and diversity loss can be severe if $N_e$ drops to a few dozen.

Hatchery programs, simply by virtue of creating more fish, can increase $N_e$. In very small populations, this increase can be a benefit, making selection more effective and reducing other small-population risks (e.g., (e.g., Lacy 1987; Whitlock 2000; Willi et al. 2006). Conservation hatchery programs can thus serve to protect genetic diversity; several programs, such as the Snake River sockeye salmon program, are important genetic reserves. However, hatchery programs can also directly depress $N_e$ by two principal methods. One is by the simple removal of fish from the population so that they can be used in the hatchery broodstock. If a substantial portion of the population is taken into a hatchery, the hatchery becomes responsible for that portion of the effective size, and if the operation fails, the effective size of the population will be reduced (Waples and Do 1994). Two is when $N_e$ is reduced considerably below the census number of broodstock by using a skewed sex ratio, spawning males multiple times (Busack 2007), and by pooling gametes. Pooling semen is especially problematic because when semen of several males is mixed and applied to eggs, a large portion of the eggs may be fertilized by a single male (Gharrett and Shirley 1985; Withler 1988). An extreme form of $N_e$ reduction is the Ryman-Laikre effect (Ryman et al. 1995; Ryman and Laikre 1991), when $N_e$ is reduced through the return to the spawning grounds of large numbers of hatchery fish from very few parents. On the other hand, factorial mating schemes, in which fish are systematically mated multiple times, can be used to increase $N_e$ (Busack and Knudsen 2007; Fiumera et al. 2004).

Inbreeding depression, another $N_e$-related phenomenon, is caused by the mating of closely related individuals (e.g., siblings, half-siblings, cousins). The smaller the population, the more likely spawners will be related. Related individuals are likely to contain similar genetic material, and the resulting offspring may then have reduced survival because they are less variable genetically or have double doses of deleterious mutations. The lowered fitness of fish due to inbreeding depression accentuates the genetic risk problem, helping to push a small population toward extinction.

Outbreeding effects, the second major area of genetic effects of hatchery programs, are caused by gene flow from other populations. Gene flow occurs naturally among salmon and steelhead populations, a process referred to as straying (Quinn 1993; Quinn 1997). Natural straying serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in re-colonizing vacant habitat, and straying is considered a risk only when it occurs at unnatural levels or from unnatural sources. Hatchery programs can result in straying outside natural patterns for two reasons. First, hatchery fish may exhibit reduced homing fidelity relative to natural-origin fish (Goodman 2005; Grant 1997; Jonsson et al. 2003; Quinn 1997), resulting in unnatural levels of gene flow into recipient populations, either in terms of sources or rates. Second, even if hatchery fish home at the same level of fidelity as natural-origin fish, their higher abundance can cause unnatural straying levels into recipient populations. One goal for hatchery programs should be to ensure that hatchery practices do not lead to higher rates of genetic exchange with fish from natural populations than would occur naturally (Ryman 1991). Rearing and release practices and ancestral origin of the hatchery fish can all play a role in straying (Quinn 1997).

Gene flow from other populations can have two effects. It can increase genetic diversity (e.g., Ayllon et al. 2006), which can be a benefit in small populations, but it can also alter established allele frequencies (and co-adapted gene complexes) and reduce the population's level of adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish 2007). In general, the greater the geographic separation between the source or origin of hatchery fish and the recipient natural population, the greater the genetic difference between the two populations (ICTRT 2007), and the greater potential for outbreeding depression. For this reason, NMFS advises hatchery action agencies to develop locally derived hatchery broodstock. Additionally, unusual rates of straying into other populations within or beyond the population's MPG, salmon ESU, or a steelhead DPS can have an homogenizing effect, decreasing intra-population genetic variability (e.g.(Vasemagi et al. 2005), and increasing risk to population diversity, one of the four attributes measured to determine population viability. Reduction of within-population and among-population diversity can reduce adaptive potential.

The proportion of hatchery fish (pHOS)[7] among natural spawners is often used as a surrogate measure of gene flow. Appropriate cautions and qualifications should be considered when using this proportion to analyze outbreeding effects. Adult salmon may wander on their return migration, entering and then leaving tributary streams before spawning (Pastor 2004). These "dip-in" fish may be detected and counted as strays, but may eventually spawn in other areas, resulting in an overestimate of the number of strays that potentially interbreed with the natural population (Keefer et al. 2008). Caution must also be taken in assuming that strays contribute genetically in proportion to their abundance. Several studies demonstrate little genetic impact from straying despite a considerable presence of strays in the spawning population (Blankenship

[7] It is important to reiterate that as NMFS analyzes them, outbreeding effects are a risk only when the hatchery fish are from a different population than the naturally produced fish. If they are from the same population, then the risk is from hatchery-influenced selection.

et al. 2007; Saisa et al. 2003). The causative factors for poorer breeding success of strays are likely similar to those identified as responsible for reduced productivity of hatchery-origin fish in general, e.g., differences in run and spawn timing, spawning in less productive habitats, and reduced survival of their progeny (Leider et al. 1990; Reisenbichler and McIntyre 1977; Williamson et al. 2010).

Hatchery-influenced selection (often called domestication), the third major area of genetic effects of hatchery programs, occurs when selection pressures imposed by hatchery spawning and rearing differ greatly from those imposed by the natural environment and causes genetic change that is passed on to natural populations through interbreeding with hatchery-origin fish. These differing selection pressures can be a result of differences in environments or a consequence of protocols and practices used by a hatchery program. Hatchery-influenced selection can range from relaxation of selection that would normally occur in nature, to selection for different characteristics in the hatchery and natural environments, to intentional selection for desired characteristics (Waples 1999).

Genetic change and fitness reduction resulting from hatchery-influenced selection depends on: (1) the difference in selection pressures; (2) the exposure or amount of time the fish spends in the hatchery environment; and (3) the duration of hatchery program operation (i.e., the number of generations that fish are propagated by the program). For an individual, the amount of time a fish spend in the hatchery mostly equates to fish culture. For a population, exposure is determined by the proportion of natural-origin fish in the hatchery broodstock, the proportion of natural spawners consisting of hatchery-origin fish (Ford 2002; Lynch and O'Hely 2001), and the number of years the exposure takes place. In assessing risk or determining impact, all three factors must be considered. Strong selective fish culture with low hatchery-wild interbreeding can pose less risk than relatively weaker selective fish culture with high levels of interbreeding.

Most of the empirical evidence of fitness depression due to hatchery-influenced selection comes from studies of species that are reared in the hatchery environment for an extended period – one to two years – prior to release (Berejikian and Ford 2004). Exposure time in the hatchery for fall and summer Chinook salmon and Chum salmon is much shorter, just a few months. One especially well-publicized steelhead study (Araki et al. 2007; Araki et al. 2008), showed dramatic fitness declines in the progeny of naturally spawning Hood River hatchery steelhead. Researchers and managers alike have wondered if these results could be considered a potential outcome applicable to all salmonid species, life-history types, and hatchery rearing strategies, but researchers have not reached a definitive conclusion.

Besides the Hood River steelhead work, a number of studies are available on the relative reproductive success (RRS) of hatchery- and natural-origin fish (e.g., Berntson et al. 2011; Ford et al. 2012; Hess et al. 2012; Theriault et al. 2011). All have shown that, generally, hatchery-origin fish have lower reproductive success; however, the differences have not always been statistically significant and, in some years in some studies, the opposite was true. Lowered reproductive success of hatchery-origin fish in these studies is typically considered evidence of hatchery-influenced selection. Although RRS may be a result of hatchery-influenced selection,

studies must be carried out for multiple generations to unambiguously detect a genetic effect. To date, only the Hood River steelhead (Araki et al. 2007; Christie et al. 2011) and Wenatchee spring Chinook salmon (Ford et al. 2012) RRS studies have reported multiple-generation effects.

Critical information for analysis of hatchery-induced selection includes the number, location, and timing of naturally spawning hatchery fish, the estimated level of gene flow between hatchery-origin and natural-origin fish, the origin of the hatchery stock (the more distant the origin compared to the affected natural population, the greater the threat), the level and intensity of hatchery selection and the number of years the operation has been run in this way. Efforts to control and evaluate the risk of hatchery-influenced selection are currently largely focused on gene flow between natural-origin and hatchery-origin fish[8]. The Interior Columbia Technical Recovery Team (ICTRT) developed guidelines based on the proportion of spawners in the wild consisting of hatchery-origin fish (pHOS) (Figure 4).

More recently, the Hatchery Scientific Review Group (HSRG) developed gene-flow guidelines based on mathematical models developed by (Ford 2002) and by (Lynch and O'Hely 2001). Guidelines for isolated programs are based on pHOS, but guidelines for integrated programs are based also on a metric called proportionate natural influence (PNI), which is a function of pHOS and the proportion of natural-origin fish in the broodstock (pNOB)[9]. PNI is, in theory, a reflection of the relative strength of selection in the hatchery and natural environments; a PNI value greater than 0.5 indicates dominance of natural selective forces. The HSRG guidelines vary according to type of program and conservation importance of the population. When the underlying natural population is of high conservation importance, the guidelines are a pHOS of no greater than 5 percent for isolated programs. For integrated programs, the guidelines are a pHOS no greater than 30 percent and PNI of at least 67 percent for integrated programs (HSRG 2009). Higher levels of hatchery influence are acceptable, however, when a population is at high risk or very high risk of extinction due to low abundance and the hatchery program is being used to conserve the population and reduce extinction risk in the short-term. (HSRG 2004)offered additional guidance regarding isolated programs, stating that risk increases dramatically as the level of divergence increases, especially if the hatchery stock has been selected directly or indirectly for characteristics that differ from the natural population. The HSRG recently produced an update report (HSRG 2014) that stated that the guidelines for isolated programs may

[8] Gene flow between natural-origin and hatchery-origin fish is often interpreted as meaning actual matings between natural-origin and hatchery-origin fish. In some contexts, it can mean that. However, in this document, unless otherwise specified, gene flow means contributing to the same progeny population. For example, hatchery-origin spawners in the wild will either spawn with other hatchery-origin fish or with natural-origin fish. Natural-origin spawners in the wild will either spawn with other natural-origin fish or with hatchery-origin fish. But all these matings, to the extent they are successful, will generate the next generation of natural-origin fish. In other words, all will contribute to the natural-origin gene pool.

[9] PNI is computed as pNOB/(pNOB+pHOS). This statistic is really an approximation of the true proportionate natural influence, but operationally the distinction is unimportant.

not provide as much protection from fitness loss as the corresponding guidelines for integrated programs.

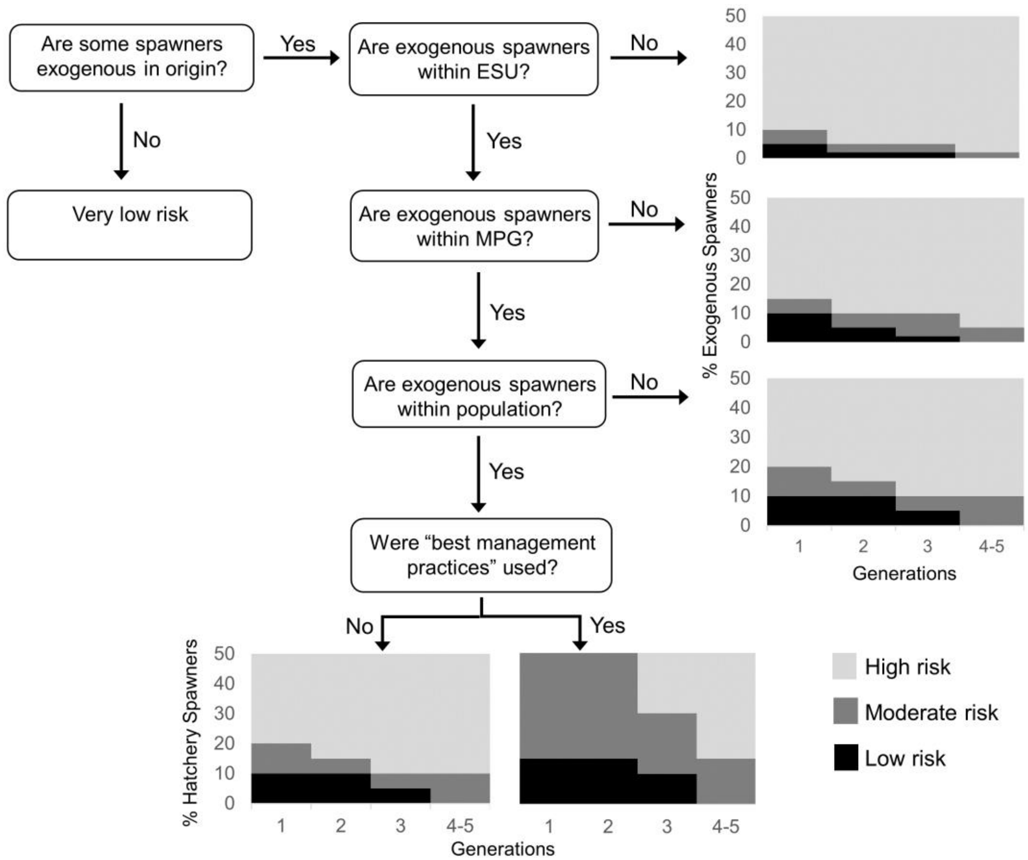


**Figure 4. ICTRT (2007b) risk criteria associated with spawner composition for viability assessment of exogenous spawners on maintaining natural patterns of gene flow. Exogenous fish are considered to be all fish of hatchery origin, and non-normative strays of natural origin.**

Another HSRG team recently reviewed California hatchery programs and developed guidelines that differed considerably from those developed by the earlier group (California HSRG 2012). The California HSRG felt that truly isolated programs in which no hatchery-origin returnees interact genetically with natural populations were impossible in California, and was "generally unsupportive" of the concept. However, if programs were to be managed as isolated, they recommend a pHOS of less than 5 percent. They rejected development of overall pHOS guidelines for integrated programs because the optimal pHOS will depend upon multiple factors, such as "the amount of spawning by natural-origin fish in areas integrated with the hatchery, the value of pNOB, the importance of the integrated population to the larger stock, the fitness differences between hatchery- and natural-origin fish, and societal values, such as angling opportunity." They recommended that program-specific plans be developed with corresponding

population-specific targets and thresholds for pHOS, pNOB, and PNI that reflect these factors. However, they did state that PNI should exceed 50 percent in most cases, although in supplementation or reintroduction programs the acceptable pHOS could be much higher than 5 percent, even approaching 100 percent at times. They also recommended for conservation programs that pNOB approach 100 percent, but pNOB levels should not be so high they pose demographic risk to the natural population.

Discussions involving pHOS can be problematic due to variation in its definition. Most commonly, the term pHOS refers to the proportion of the total natural spawning population consisting of hatchery fish, and the term has been used in this way in all NMFS documents. However, the HSRG has defined pHOS inconsistently in its Columbia Basin system report, equating it with “the proportion of the natural spawning population that is made up of hatchery fish” in the Conclusion, Principles and Recommendations section (HSRG 2009), but with “the proportion of *effective* hatchery-origin spawners” in their gene-flow criteria. In addition, in their Analytical Methods and Information Sources section (appendix C in HSRG 2009) they introduce a new term, *effective pHOS* ($pHOS_{eff)}$ defined as the effective proportion of hatchery fish in the naturally spawning population. This confusion was cleared up in the 2014 update document, where it is clearly stated that the metric of interest is effective pHOS (HSRG 2014).

The HSRG recognized that hatchery fish spawning naturally may on average produce fewer adult progeny than natural-origin spawners, as described above. To account for this difference the HSRG defined *effective* pHOS as:

$$pHOS_{eff} = RRS * pHOS_{census}$$

where $pHOS_{census}$ is the proportion of the naturally spawning population that is composed of hatchery-origin adults (HSRG 2014). In the 2014 report, the HSRG explicitly addressed the differences between *census* pHOS and *effective* pHOS, by defining PNI as:

$$PNI = \frac{pNOB}{(pNOB + pHOS_{eff})}$$

NMFS feels that adjustment of census pHOS by RRS should be done very cautiously, not nearly as freely as the HSRG document would suggest because the Ford (2002) model, which is the foundation of the HSRG gene-flow guidelines, implicitly includes a genetic component of RRS. In that model, hatchery fish are expected to have RRS < 1 (compared to natural fish) due to selection in the hatchery. A component of reduced RRS of hatchery fish is therefore already incorporated in the model and by extension the calculation of PNI. Therefore reducing pHOS values by multiplying by RRS will result in underestimating the relevant pHOS and therefore overestimating PNI. Such adjustments would be particularly inappropriate for hatchery programs with low pNOB, as these programs may well have a substantial reduction in RRS due to genetic factors already incorporated in the model.

In some cases, adjusting pHOS downward may be appropriate, however, particularly if there is strong evidence of a non-genetic component to RRS. Wenatchee spring Chinook salmon

(Williamson et al. 2010) is an example case with potentially justified adjustment by RRS, where the spatial distribution of natural-origin and hatchery-origin spawners differs, and the hatchery-origin fish tend to spawn in poorer habitat. However, even in a situation like the Wenatchee spring Chinook salmon, it is unclear how much of an adjustment would be appropriate. By the same logic, it might also be appropriate to adjust pNOB in some circumstances. For example, if hatchery juveniles produced from natural-origin broodstock tend to mature early and residualize (due to non-genetic effects of rearing), as has been documented in some spring Chinook salmon and steelhead programs, the "effective" pNOB might be much lower than the census pNOB.

It is also important to recognize that PNI is only an approximation of relative trait value, based on a model that is itself very simplistic. To the degree that PNI fails to capture important biological information, it would be better to work to include this biological information in the underlying models rather than make ad hoc adjustments to a statistic that was only intended to be rough guideline to managers. We look forward to seeing this issue further clarified in the near future. In the meantime, except for cases in which an adjustment for RRS has strong justification, NMFS feels that census pHOS, rather than effective pHOS, is the appropriate metric to use for genetic risk evaluation.

Additional perspective on pHOS that is independent of HSRG modelling is provided by a simple analysis of the expected proportions of mating types. Figure 5 shows the expected proportion of mating types in a mixed population of natural-origin (N) and hatchery-origin (H) fish as a function of the census pHOS, assuming that N and H adults mate randomly[10]. For example, at a census pHOS level of 10 percent, 81 percent of the matings will be NxN, 18 percent will be NxH, and 1 percent will be HxH. This diagram can also be interpreted as probability of parentage of naturally produced progeny, assuming random mating and equal reproductive success of all mating types. Under this interpretation, progeny produced by a parental group with a pHOS level of 10 percent will have an 81 percent chance of having two natural-origin parents, etc.

Random mating assumes that the natural-origin and hatchery-origin spawners overlap completely spatially and temporally. As overlap decreases, the proportion of NxH matings decreases; with no overlap, the proportion of NxN matings is 1 minus pHOS and the proportion of HxH matings equals pHOS. RRS does not affect the mating type proportions directly but changes their effective proportions. Overlap and RRS can be related. For example, in the Wenatchee River, hatchery spring Chinook salmon tend to spawn lower in the system than natural-origin fish, and this accounts for a considerable amount of their lowered reproductive success (Williamson et al. 2010). In that particular situation the hatchery-origin fish were spawning in inferior habitat.

[10] These computations are purely theoretical, based on a simple mathematical binomial expansion $((a+b)^2=a^2 + 2ab + b^2)$.

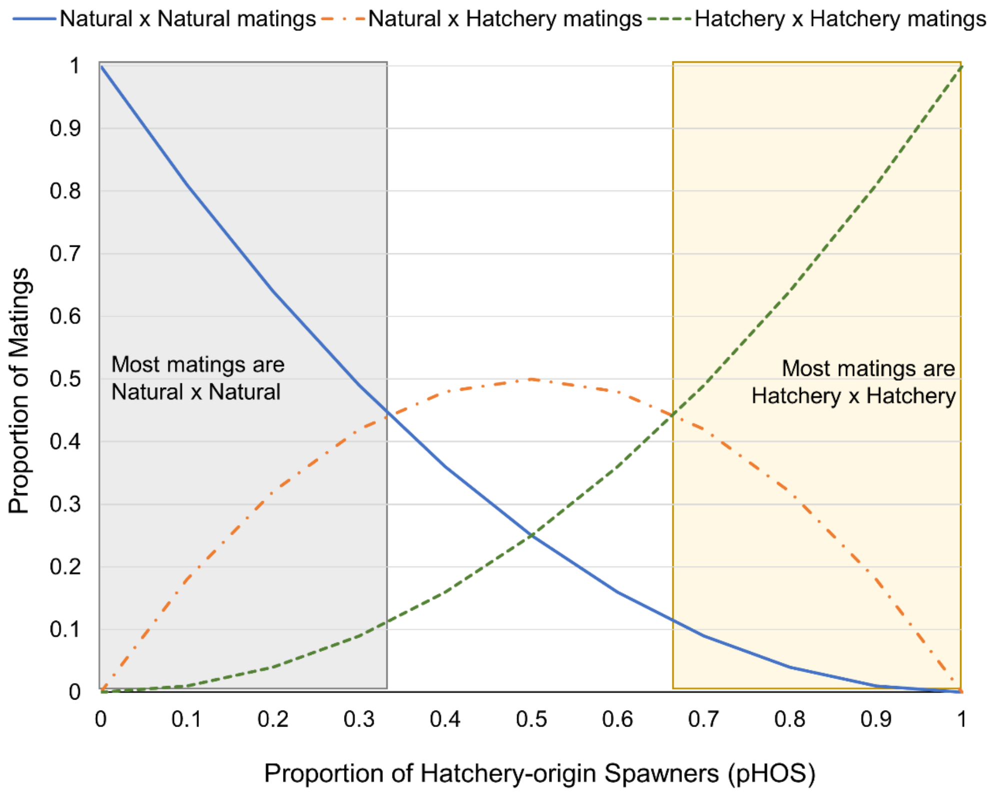


**Figure 5. Relative proportions of types of matings as a function of proportion of hatchery-origin fish on the spawning grounds (pHOS).**

### 5.2.2. Ecological effects

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer to effects from competition for spawning sites and redd superimposition, contributions to marine-derived nutrients, and the removal of fine sediments from spawning gravels. Ecological effects on the spawning grounds may be positive or negative. To the extent that hatcheries contribute added fish to the ecosystem, there can be positive effects. For example, when anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Gresh et al. 2000; Kline et al. 1990; Larkin and Slaney 1996; Murota 2003; Piorkowski 1995; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Bell 2001; Bilton et al. 1982; Bradford et al. 2000; Brakensiek 2002; Hager and Noble 1976; Hartman and Scrivener 1990; Holtby 1988; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996; Ward and Slaney 1988).

Additionally, studies have demonstrated that perturbation of spawning gravels by spawning salmonids loosens cemented (compacted) gravel areas used by spawning salmon (e.g., (Montgomery et al. 1996). The act of spawning also coarsens gravel in spawning reaches, removing fine material that blocks interstitial gravel flow and reduces the survival of incubating eggs in egg pockets of redds.

The added spawner density resulting from hatchery-origin fish spawning in the wild can have negative consequences at times. In particular, the potential exists for hatchery-derived fish to superimpose or destroy the eggs and embryos of ESA-listed species when there is spatial overlap between hatchery and natural spawners. Redd superimposition has been shown to be a cause of egg loss in pink salmon and other species (e.g., Fukushima et al. 1998).

### 5.2.3. Adult Collection Facilities

The analysis also considers the effects from encounters with natural-origin fish that are incidental to broodstock collection. Here, NMFS analyzes effects from sorting, holding, and handling natural-origin fish in the course of broodstock collection. Some programs collect their broodstock from fish voluntarily entering the hatchery, typically into a ladder and holding pond, while others sort through the run at large, usually at a weir, ladder, or sampling facility. Generally speaking, the more a hatchery program accesses the run at large for hatchery broodstock – that is, the more fish that are handled or delayed during migration – the greater the negative effect on natural-origin and hatchery-origin fish that are intended to spawn naturally and on ESA-listed species. The information NMFS uses for this analysis includes a description of the facilities, practices, and protocols for collecting broodstock, the environmental conditions under which broodstock collection is conducted, and the encounter rate for ESA-listed fish.

NMFS also analyzes the effects of structures, either temporary or permanent, that are used to collect hatchery broodstock, and remove hatchery fish from the river or stream and prevent them from spawning naturally, on juvenile and adult fish from encounters with these structures. NMFS determines through the analysis, for example, whether the spatial structure, productivity, or abundance of a natural population is affected when fish encounter a structure used for broodstock collection, usually a weir or ladder.

## 5.3. Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas

NMFS also analyzes the potential for competition and predation when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas. The level of effect for this factor ranges from neutral or negligible to negative.

### 5.3.1. Competition

Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct or indirect interactions. Direct interactions occur when hatchery-origin fish interfere with the accessibility to limited resources by natural-origin fish, and indirect interactions occur when the utilization of a limited resource by hatchery fish reduces the amount

available for fish from the natural population (Rensel et al. 1984). Natural-origin fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, are of equal or greater size, take up residency before naturally produced fry emerge from redds, and residualize. Hatchery fish might alter natural-origin salmon behavioral patterns and habitat use, making natural-origin fish more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter natural-origin salmonid migratory responses or movement patterns, leading to a decrease in foraging success by the natural-origin fish (Hillman and Mullan 1989; Steward and Bjornn 1990). Actual impacts on natural-origin fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

Specific hazards associated with competitive impacts of hatchery salmonids on listed natural-origin salmonids may include competition for food and rearing sites (NMFS 2012). In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (Rensel et al. 1984) concluded that naturally produced coho and Chinook salmon and steelhead are all potentially at "high risk" due to competition (both interspecific and intraspecific) from hatchery fish of any of these three species. In contrast, the risk to naturally produced pink, chum, and sockeye salmon due to competition from hatchery salmon and steelhead was judged to be low.

Several factors influence the risk of competition posed by hatchery releases: whether competition is intra- or interspecific; the duration of freshwater co-occurrence of hatchery and natural-origin fish; relative body sizes of the two groups; prior residence of shared habitat; environmentally induced developmental differences; and density in shared habitat (Tatara and Berejikian 2012). Intraspecific competition would be expected to be greater than interspecific, and competition would be expected to increase with prolonged freshwater co-occurrence. Hatchery smolts are commonly larger than natural-origin fish, and larger fish usually are superior competitors. However, natural-origin fish have the competitive advantage of prior residence when defending territories and resources in shared natural freshwater habitat. Tatara and Berejikian (2012) further reported that hatchery-influenced developmental differences from co-occurring natural-origin fish are variable and can favor both hatchery- and natural-origin fish. They concluded that of all factors, fish density of the composite population in relation to habitat carrying capacity likely exerts the greatest influence.

En masse hatchery salmon smolt releases may cause displacement of rearing natural-origin juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration by natural-origin juvenile salmonids. Pearsons et al. (1994) reported small-scale displacement of juvenile naturally produced rainbow trout from stream sections by hatchery steelhead. Small-scale displacements and agonistic interactions observed between hatchery steelhead and natural-origin juvenile trout were most likely a result of size differences and not something inherently different about hatchery fish.

A proportion of the smolts released from a hatchery may not migrate to the ocean but rather reside for a period of time in the vicinity of the release point. These non-migratory fish (residuals) may directly compete for food and space with natural-origin juvenile salmonids of similar age. Although this behavior has been studied and observed, most frequently in the case of hatchery steelhead, residualism has been reported as a potential issue for hatchery coho and Chinook salmon as well. Adverse impacts of residual hatchery Chinook and coho salmon on natural-origin salmonids can occur, especially given that the number of smolts per release is generally higher; however, the issue of residualism for these species has not been as widely investigated compared to steelhead. Therefore, for all species, monitoring of natural stream areas in the vicinity of hatchery release points may be necessary to determine the potential effects of hatchery smolt residualism on natural-origin juvenile salmonids.

The risk of adverse competitive interactions between hatchery- and natural-origin fish can be minimized by:

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (California HSRG 2012; Steward and Bjornn 1990)
- Operating hatcheries such that hatchery fish are reared to a size sufficient to ensure that smoltification occurs in nearly the entire population
- Releasing hatchery smolts in lower river areas, below areas used for stream-rearing by naturally produced juveniles
- Monitoring the incidence of non-migratory smolts (residuals) after release and adjusting rearing strategies, release location, and release timing if substantial competition with naturally rearing juveniles is determined likely

Critical to analyzing competition risk is information on the quality and quantity of spawning and rearing habitat in the Action Area,[11] including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity. Additional important information includes the abundance, distribution, and timing for naturally spawning hatchery fish and natural-origin fish; the timing of emergence; the distribution and estimated abundance for progeny from both hatchery and natural-origin natural spawners; the abundance, size, distribution, and timing for juvenile hatchery fish in the Action Area; and the size of hatchery fish relative to co-occurring natural-origin fish.

### 5.3.2. Predation

Another potential ecological effect of hatchery releases is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead. Predation, either direct (consumption by hatchery fish) or indirect (increases in predation by other predator species due to enhanced attraction), can result from hatchery fish released into the wild. Considered here is predation by hatchery-origin fish, the progeny of naturally spawning hatchery fish, and avian and other

[11] "Action area" means all areas to be affected directly or indirectly by the action in which the effects of the action can be meaningfully detected and evaluated.

predators attracted to the area by an abundance of hatchery fish. Hatchery fish originating from egg boxes and fish planted as non-migrant fry or fingerlings can prey upon fish from the local natural population during juvenile rearing. Hatchery fish released at a later stage, so they are more likely to emigrate quickly to the ocean, can prey on fry and fingerlings that are encountered during the downstream migration. Some of these hatchery fish do not emigrate and instead take up residence in the stream (residuals) where they can prey on stream-rearing juveniles over a more prolonged period, as discussed above. The progeny of naturally spawning hatchery fish also can prey on fish from a natural population and pose a threat. In general, the threat from predation is greatest when natural populations of salmon and steelhead are at low abundance, when spatial structure is already reduced, when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility.

(Rensel et al. 1984) rated most risks associated with predation as unknown because there was relatively little documentation in the literature of predation interactions in either freshwater or marine areas at the time. More studies are now available, but they are still too sparse to allow many generalizations to be made about risk. Newly released hatchery-origin salmon and steelhead may prey on juvenile fall Chinook and steelhead and other juvenile salmon in the freshwater and marine environments (Hargreaves and LeBrasseur 1986; Hawkins and Tipping 1999; Pearsons and Fritts 1999). Low predation rates have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012). Hatchery steelhead release timing and protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook fry, which had already emigrated or had grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead entered the rivers (Sharpe et al. 2008). Hawkins (1998) documented hatchery spring Chinook salmon predation on naturally produced fall Chinook salmon juveniles in the Lewis River. Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (coho salmon and cutthroat, predominately) than their hatchery counterparts.

Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to naturally produced fish (Rensel et al. 1984). Due to their location in the stream or river, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation. Their vulnerability is believed to be greatest immediately upon emergence from the gravel and then their vulnerability decreases as they move into shallow, shoreline areas (USFWS 1994). Emigration out of important rearing areas and foraging inefficiency of newly released hatchery smolts may reduce the degree of predation on salmonid fry (USFWS 1994).

Some reports suggest that hatchery fish can prey on fish that are up to 1/2 their length (HSRG 2004; Pearsons and Fritts 1999), but other studies have concluded that salmonid predators prey on fish 1/3 or less their length (Beauchamp 1990; Cannamela 1992; CBFWA 1996; Hillman and Mullan 1989; Horner 1978). Hatchery fish may also be less efficient predators as compared to

their natural-origin conspecifics, reducing the potential for predation impacts (Bachman 1984; Olla et al. 1998; Sosiak et al. 1979).

There are several steps that hatchery programs can implement to reduce or avoid the threat of predation:

- Releasing all hatchery fish as actively migrating smolts through volitional release practices so that the fish migrate quickly seaward, limiting the duration of interaction with any co-occurring natural-origin fish downstream of the release site.
- Ensuring that a high proportion of the population have physiologically achieved full smolt status. Juvenile salmon tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Releasing hatchery smolts in lower river areas near river mouths and below upstream areas used for stream-rearing young-of-the-year naturally produced salmon fry, thereby reducing the likelihood for interaction between the hatchery and naturally produced fish.
- Operating hatchery programs and releases to minimize the potential for residualism.

### 5.3.3. Disease

The release of hatchery fish and hatchery effluent into juvenile rearing areas can lead to transmission of pathogens, contact with chemicals or altering of environmental parameters (e.g., dissolved oxygen) that can result in disease outbreaks. Fish diseases can be subdivided into two main categories: infectious and non-infectious. Infectious diseases are those caused by pathogens such as viruses, bacteria, and parasites. Noninfectious diseases are those that cannot be transmitted between fish and are typically caused by genetic or environmental factors (e.g., low dissolved oxygen). Pathogens can also be categorized as exotic or endemic. For our purposes, exotic pathogens are those that have no history of occurrence within state boundaries. For example, *Oncorhynchus masou virus* (OMV) would be considered an exotic pathogen if identified anywhere in Washington state. Endemic pathogens are native to a state, but may not be present in all watersheds.

In natural fish populations, the risk of disease associated with hatchery programs may increase through a variety of mechanisms (Naish et al. 2008), including:

- Introduction of exotic pathogens
- Introduction of endemic pathogens to a new watershed
- Intentional release of infected fish or fish carcasses
- Continual pathogen reservoir
- Pathogen amplification

The transmission of pathogens between hatchery and natural fish can occur indirectly through hatchery water influent/effluent or directly via contact with infected fish. Within a hatchery, the likelihood of transmission leading to an epizootic (i.e., disease outbreak) is increased compared

to the natural environment because hatchery fish are reared at higher densities and closer proximity than would naturally occur. During an epizootic, hatchery fish can shed relatively large amounts of pathogen into the hatchery effluent and ultimately, the environment, amplifying pathogen numbers. However, few, if any, examples of hatcheries contributing to an increase in disease in natural populations have been reported (Naish et al. 2008; Steward and Bjornn 1990). This lack of reporting is because both hatchery and natural-origin salmon and trout are susceptible to the same pathogens (Noakes et al. 2000), which are often endemic and ubiquitous (e.g., *Renibacterium salmoninarum*, the cause of Bacterial Kidney Disease).

Adherence to a number of state, federal, and tribal fish health policies limits the disease risks associated with hatchery programs (IHOT 1995; NWIFC and WDFW 2006; ODFW 2003; USFWS 2004). Specifically, the policies govern the transfer of fish, eggs, carcasses, and water to prevent the spread of exotic and endemic reportable pathogens. For all pathogens, both reportable and non-reportable, pathogen spread and amplification are minimized through regular monitoring (typically monthly) removing mortalities, and disinfecting all eggs. Vaccines may provide additional protection from certain pathogens when available (e.g., *Vibrio anguillarum*). If a pathogen is determined to be the cause of fish mortality, treatments (e.g., antibiotics) will be used to limit further pathogen transmission and amplification. Some pathogens, such as *infectious hematopoietic necrosis virus* (IHNV), have no known treatment. Thus, if an epizootic occurs for those pathogens, the only way to control pathogen amplification is to cull infected individuals or terminate all susceptible fish. In addition, current hatchery operations often rear hatchery fish on a timeline that mimics their natural life history, which limits the presence of fish susceptible to pathogen infection and prevents hatchery fish from becoming a pathogen reservoir when no natural fish hosts are present.

In addition to the state, federal and tribal fish health policies, disease risks can be further minimized by preventing pathogens from entering the hatchery facility through the treatment of incoming water (e.g., by using ozone) or by leaving the hatchery through hatchery effluent (Naish et al. 2008). Although preventing the exposure of fish to any pathogens prior to their release into the natural environment may make the hatchery fish more susceptible to infection after release into the natural environment, reduced fish densities in the natural environment compared to hatcheries likely reduces the risk of fish encountering pathogens at infectious levels (Naish et al. 2008). Treating the hatchery effluent would also minimize amplification, but would not reduce disease outbreaks within the hatchery itself caused by pathogens present in the incoming water supply. Another challenge with treating hatchery effluent is the lack of reliable, standardized guidelines for testing or a consistent practice of controlling pathogens in effluent (LaPatra 2003). However, hatchery facilities located near marine waters likely limit freshwater pathogen amplification downstream of the hatchery without human intervention because the pathogens are killed before transmission to fish when the effluent mixes with saltwater.

Noninfectious diseases are those that cannot be transmitted between fish and are typically caused by genetic or environmental factors (e.g., low dissolved oxygen). Hatchery facilities routinely

use a variety of chemicals for treatment and sanitation purposes. Chlorine levels in the hatchery effluent, specifically, are monitored with a National Pollutant Discharge Elimination System (NPDES) permit administered by the Environmental Protection Agency. Other chemicals are discharged in accordance with manufacturer instructions. The NPDES permit also requires monitoring of settleable and unsettleable solids, temperature, and dissolved oxygen in the hatchery effluent on a regular basis to ensure compliance with environmental standards and to prevent fish mortality. In contrast to infectious diseases, which typically are manifest by a limited number of life stages and over a protracted time period, non-infectious diseases caused by environmental factors typically affect all life stages of fish indiscriminately and over a relatively short period of time. One group of non-infectious diseases that are expected to occur rarely in current hatchery operations are those caused by nutritional deficiencies because of the vast literature available on successful rearing of salmon and trout in aquaculture.

### 5.3.4. Acclimation

One factor the can affect hatchery fish distribution and the potential to spatially overlap with natural-origin spawners, and thus the potential for genetic and ecological impacts, is the acclimation (the process of allowing fish to adjust to the environment in which they will be released) of hatchery juveniles before release. Acclimation of hatchery juvenile before release increases the probability that hatchery adults will home back to the release location, reducing their potential to stray into natural spawning areas. Acclimating fish for a period of time also allows them to recover from the stress caused by the transportation of the fish to the release location and by handling. (Dittman and Quinn 2008) provide an extensive literature review and introduction to homing of Pacific salmon. They note that, as early as the 19th century, marking studies had shown that salmonids would home to the stream, or even the specific reach, where they originated. The ability to home to their home or "natal" stream is thought to be due to odors to which the juvenile salmonids were exposed while living in the stream (olfactory imprinting) and migrating from it years earlier (Dittman and Quinn 2008; Keefer and Caudill 2014). Fisheries managers use this innate ability of salmon and steelhead to home to specific streams by using acclimation ponds to support the reintroduction of species into newly accessible habitat or into areas where they have been extirpated (Dunnigan 1999; Quinn 1997; YKFP 2008).

(Dittman and Quinn 2008) reference numerous experiments that indicated that a critical period for olfactory imprinting is during the parr-smolt transformation, which is the period when the salmonids go through changes in physiology, morphology, and behavior in preparation for transitioning from fresh water to the ocean (Beckman et al. 2000; Hoar 1976). Salmon species with more complex life histories (e.g., sockeye salmon) may imprint at multiple times from emergence to early migration (Dittman et al. 2010). Imprinting to a particular location, be it the hatchery, or an acclimation pond, through the acclimation and release of hatchery salmon and steelhead is employed by fisheries managers with the goal that the hatchery fish released from these locations will return to that particular site and not stray into other areas (Bentzen et al. 2001; Fulton and Pearson 1981; Hard and Heard 1999; Kostow 2009; Quinn 1997; Westley et al. 2013). However, this strategy may result in varying levels of success in regards to the proportion

of the returning fish that stray outside of their natal stream. (e.g., (Clarke et al. 2011; Kenaston et al. 2001).

Having hatchery salmon and steelhead home to a particular location is one measure that can be taken to reduce the proportion of hatchery fish in the naturally spawning population. By having the hatchery fish home to a particular location, those fish can be removed (e.g., through fisheries, use of a weir) or they can be isolated from primary spawning areas. Factors that can affect the success of homing include:

- The timing of the acclimation, such that a majority of the hatchery juveniles are going through the parr-smolt transformation during acclimation
- A water source unique enough to attract returning adults
- Whether or not the hatchery fish can access the stream reach where they were released
- Whether or not the water quantity and quality is such that returning hatchery fish will hold in that area before removal and/or their harvest in fisheries.

## 5.4. Factor 4. Research, monitoring, and evaluation that exists because of the hatchery program

NMFS also analyzes proposed RM&E for its effects on listed species and on designated critical habitat. The level of effect for this factor ranges from positive to negative.

Generally speaking, negative effects on the fish from RM&E are weighed against the value or benefit of new information, particularly information that tests key assumptions and that reduces uncertainty. RM&E actions can cause harmful changes in behavior and reduced survival; such actions include, but are not limited to:

- Observation during surveying
- Collecting and handling (purposeful or inadvertent)
- Holding the fish in captivity, sampling (e.g., the removal of scales and tissues)
- Tagging and fin-clipping, and observing the fish (in-water or from the bank)

### 5.4.1. Observing/Harassing

For some parts of the proposed studies, listed fish would be observed in-water (e.g., by snorkel surveys, wading surveys, or observation from the banks). Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water, or behind/under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. These avoidance behaviors are expected to be

in the range of normal predator and disturbance behaviors. Redds may be visually inspected, but would not be walked on.

### 5.4.2. Capturing/handling

Any physical handling or psychological disturbance is known to be stressful to fish (Sharpe et al. 1998). Primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and holding vessel), dissolved oxygen conditions, the amount of time fish are held out of the water, and physical trauma. Stress increases rapidly if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied regularly. Decreased survival can result from high stress levels because stress can be immediately debilitating, and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared regularly.

### 5.4.3. Fin clipping and tagging

Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied, but fin clips do not generally alter fish growth (Brynildson and Brynildson 1967; Gjerde and Refstie 1988). Mortality among fin-clipped fish is variable, but can be as high as 80 percent (Nicola and Cordone 1973). In some cases, though, no significant difference in mortality was found between clipped and un-clipped fish (Gjerde and Refstie 1988; Vincent-Lang 1993). The mortality rate typically depends on which fin is clipped. Recovery rates are generally higher for adipose- and pelvic-fin-clipped fish than for those that have clipped pectoral, dorsal, or anal fins (Nicola and Cordone 1973), probably because the adipose and pelvic fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). However, some work has shown that fish without an adipose fin may have a more difficult time swimming through turbulent water (Buckland-Nicks et al. 2011; Reimchen and Temple 2003).

In addition to fin clipping, PIT tags and CWTs are included in the Proposed Action. PIT tags are inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled, so it is critical that researchers ensure that the operations take place in the safest possible manner. Tagging needs to take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a recovery holding tank.

Most studies have concluded that PIT tags generally have very little effect on growth, mortality, or behavior. Early studies of PIT tags showed no long-term effect on growth or survival (Prentice et al. 1987; Prentice and Park 1984; Rondorf and Miller 1994). In a study between the tailraces of Lower Granite and McNary Dams (225 km), (Hockersmith et al. 2000) concluded that the performance of Chinook salmon was not adversely affected by orally or surgically implanted sham radio tags or PIT tags. However, (Knudsen et al. 2009) found that, over several brood

years, PIT tag induced smolt-adult mortality in Yakima River spring Chinook salmon averaged 10.3 percent and was at times as high as 33.3 percent.

Coded-wire tags are made of magnetized, stainless-steel wire and are injected into the nasal cartilage of a salmon and thus cause little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs should be inserted are similar to those required for PIT tags. A major advantage to using CWTs is that they have a negligible effect on the biological condition or response of tagged salmon (Vander Haegen et al. 2005); however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

Mortality from tagging is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release—it can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 2000b; NMFS 2008a) that have been incorporated as terms and conditions into section 7 opinions and section 10 permits for research and enhancement. Additional monitoring principles for supplementation programs have been developed by the (Galbreath et al. 2008).

The effects of these actions should not be confused with handling effects analyzed under broodstock collection. In addition, NMFS also considers the overall effectiveness of the RM&E program. There are five factors that NMFS takes into account when it assesses the beneficial and negative effects of hatchery RM&E: (1) the status of the affected species and effects of the proposed RM&E on the species and on designated critical habitat, (2) critical uncertainties concerning effects on the species, (3) performance monitoring and determining the effectiveness of the hatchery program at achieving its goals and objectives, (4) identifying and quantifying collateral effects, and (5) tracking compliance of the hatchery program with the terms and conditions for implementing the program. After assessing the proposed hatchery RM&E and before it makes any recommendations to the action agency(s) NMFS considers the benefit or usefulness of new or additional information, whether the desired information is available from another source, the effects on ESA-listed species, and cost.

Hatchery actions also must be assessed for masking effects. For these purposes, masking is when hatchery fish included in the Proposed Action mix with and are not identifiable from other fish. The effect of masking is that it undermines and confuses RM&E and status and trends

monitoring. Both adult and juvenile hatchery fish can have masking effects. When presented with a proposed hatchery action, NMFS analyzes the nature and level of uncertainties caused by masking and whether and to what extent listed salmon and steelhead are at increased risk. The analysis also takes into account the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important RM&E.

### 5.5. Factor 5. Construction, operation, and maintenance, of facilities that exist because of the hatchery program

The construction/installation, operation, and maintenance of hatchery facilities can alter fish behavior and can injure or kill eggs, juveniles, and adults. These actions can also degrade habitat function and reduce or block access to spawning and rearing habitats altogether. Here, NMFS analyzes changes to: riparian habitat, channel morphology, habitat complexity, in-stream substrates, and water quantity and quality attributable to operation, maintenance, and construction activities. NMFS also confirms whether water diversions and fish passage facilities are constructed and operated consistent with NMFS criteria. The level of effect for this factor ranges from neutral or negligible to negative.

### 5.6. Factor 6. Fisheries that exist because of the hatchery program

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of the Proposed Action in a section 7 consultation. One is where there are fisheries that exist because of the HGMP that describes the Proposed Action (i.e., the fishery is an interrelated and interdependent action), and listed species are inadvertently and incidentally taken in those fisheries. The other is when fisheries are used as a tool to prevent the hatchery fish associated with the HGMP, including hatchery fish included in an ESA-listed salmon ESU or steelhead DPS, from spawning naturally. The level of effect for this factor ranges from neutral or negligible to negative.

"Many hatchery programs are capable of producing more fish than are immediately useful in the conservation and recovery of an ESU and can play an important role in fulfilling trust and treaty obligations with regard to harvest of some Pacific salmon and steelhead populations. For ESUs listed as threatened, NMFS will, where appropriate, exercise its authority under section 4(d) of the ESA to allow the harvest of listed hatchery fish that are surplus to the conservation and recovery needs of the ESU, in accordance with approved harvest plans" (NMFS 2005b). In any event, fisheries must be strictly regulated based on the take, including catch and release effects, of ESA-listed species.

Araki, H., W. R. Ardren, E. Olsen, B. Cooper, and M. S. Blouin. 2007. Reproductive success of captive-bred steelhead trout in the wild: Evaluation of three hatchery programs in the Hood River. Conservation Biology 21(1):181-190.

Araki, H., B. A. Berejikian, M. J. Ford, and M. S. Blouin. 2008. Fitness of hatchery-reared salmonids in the wild. Evolutionary Applications 1(2):342-355.

Ayllon, F., J. L. Martinez, and E. Garcia-Vazquez. 2006. Loss of regional population structure in Atlantic salmon, *Salmo salar* L., following stocking. ICES Journal of Marine Science 63:1269-1273.

Bachman, R. A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. Transactions of the American Fisheries Society 113(1):1-32.

Beauchamp, D. A. 1990. Seasonal and diet food habit of rainbow trout stocked as juveniles in Lake Washington. Transactions of the American Fisheries Society 119:475-485.

Beckman, B. R., and coauthors. 2000. Physiological status of naturally reared juvenile spring Chinook salmon in the Yakima River: Seasonal dynamics and changes associated with smolting. Transactions of the American Fisheries Society 129:727-753.

Beechie, T., and coauthors. 2013. Restoring Salmon Habitat for a Changing Climate. River Research and Applications 29(8):939-960.

Bell, E. 2001. Survival, Growth and Movement of Juvenile Coho Salmon (*Oncorhynchus kisutch*) Over-wintering in Alcoves, Backwaters, and Main Channel Pools in Prairie Creek, California. September, 2001. A Thesis presented to the faculty of Humboldt State University. 85p.

Bentzen, P., J. B. Olsen, J. E. McLean, T. R. Seamons, and T. P. Quinn. 2001. Kinship analysis of Pacific salmon: Insights into mating, homing, and timing of reproduction. Journal of Heredity 92:127-136.

Berejikian, B. A., and M. J. Ford. 2004. Review of Relative Fitness of Hatchery and Natural Salmon. December 2004. U.S. Dept. Commer., NOAA Technical Memorandum NMFS-NWFSC-61. 43p.

Bergman, P. K., K. B. Jefferts, H. F. Fiscus, and R. C. Hager. 1968. A preliminary evaluation of an implanted, coded wire fish tag. Fisheries Research Papers, Washington Department of Fisheries 3(1):63-84.

Berntson, E. A., R. W. Carmichael, M. W. Flesher, E. J. Ward, and P. Moran. 2011. Diminished reproductive success of steelhead from a hatchery supplementation program (Little Sheep Creek, Imnaha Basin, Oregon). Transactions of the American Fisheries Society 140:685-698.

Bigg, M. 1982. An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. Report of the International Whaling Commission 32(65):655-666.

Bilton, T., D. F. Alderdice, and J. T. Schnute. 1982. Influence of time and size at release of juvenile coho salmon (*Oncorhynchus kisutch*) on returns at maturity. Canadian Journal of Fisheries and Aquatic Sciences 39(3):426-447.

Blankenship, S. M., M. P. Small, J. Bumgarner, M. Schuck, and G. Mendel. 2007. Genetic relationships among Tucannon, Touchet, and Walla Walla river summer steelhead (*Oncorhynchus mykiss*) receiving mitigation hatchery fish from Lyons Ferry Hatchery. WDFW, Olympia, Washington. 39p.

Bordner, C. E., and coauthors. 1990. Evaluation of marking techniques for juvenile and adult white sturgeons reared in captivity. American Fisheries Society Symposium 7:293-303.

Bradford, M. J., B. J. Pyper, and K. S. Shortreed. 2000. Biological responses of sockeye salmon to the fertilization of Chilko Lake, a large lake in the interior of British Columbia. North American Journal of Fisheries Management 20:661-671.

Brakensiek, K. E. 2002. Abundance and Survival Rates of Juvenile Coho Salmon (*Oncorhynchus kisutch*) in Prairie Creek, Redwood National Park. January 7, 2002. MS Thesis. Humboldt State University, Arcata, California. 119p.

Brynildson, O. M., and C. L. Brynildson. 1967. The effect of pectoral and ventral fin removal on survival and growth of wild brown trout in a Wisconsin stream. Transactions of the American Fisheries Society 96(3):353-355.

Buckland-Nicks, J. A., M. Gillis, and T. E. Reimchen. 2011. Neural network detected in a presumed vestigial trait: ultrastructure of the salmonid adipose fin. Proceedings of the Royal Society B: Biological Sciences 297:553-563.

Busack, C. 2007. The impact of repeat spawning of males on effective number of breeders in hatchery operations. Aquaculture 270:523-528.

Busack, C., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. AFS Symposium 15:71-80.

Busack, C., and C. M. Knudsen. 2007. Using factorial mating designs to increase the effective number of breeders in fish hatcheries. Aquaculture 273:24-32.

California HSRG. 2012. California Hatchery Review Report. Prepared for the U.S. Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. 110p.

Cannamela, D. A. 1992. Potential Impacts of Releases of Hatchery Steelhead Trout "Smolts" on Wild and Natural Juvenile Chinook and Sockeye Salmon, Appendix A. A White Paper. March 1992. Idaho Department of Fish and Game, Boise, Idaho. 26p.

CBFWA. 1996. Draft Programmatic Environmental Impact Statement. Impacts of Artificial Salmon and Steelhead Production Strategies in the Columbia River Basin. December 10, 1996. Prepared by the Columbia Basin Fish and Wildlife Authority, Portland, Oregon. 475p.

Christie, M. R., M. J. Ford, and M. S. Blouin. 2014. On the reproductive successs of early-generation hatchery fish in the wild. Evolutionary Applications 7:883-896.

Christie, M. R., M. L. Marine, R. A. French, and M. S. Blouin. 2011. Genetic adaptation to captivity can occur in a single generation. Proceedings of the National Academy of Sciences 109(1):238–242.

Clarke, L. R., M. W. Flesher, S. M. Warren, and R. W. Carmichael. 2011. Survival and straying of hatchery steelhead following forced or volitional release. North American Journal of Fisheries Management 31:116-123.

Climate Impacts Group. 2004. Overview of Climate Change Impacts in the U.S. Pacific Northwest. July 29, 2004. Climate Impacts Group, University of Washington, Seattle, Washington. 13p.

Crozier, L. G., and coauthors. 2008a. Potential responses to climate change in organisms with complex life histories: Evolution and plasticity in Pacific salmon.

Crozier, L. G., R. W. Zabel, and A. F. Hamlet. 2008b. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biology 14(2):236–249.

Dalton, M., P. W. Mote, and A. K. S. [Eds.]. 2013. Climate Change in the Northwest, Implications for Our Landscapes, Waters, and Communities. Washington, DC: Island Press. 271p.

Daly, E. A., and coauthors. 2014. Juvenile steelhead distribution, migration, feeding, and growth in the Columbia River Estuary, plume, and coastal waters. Marine and Coastal Fisheries 6(1):62-80.

Dittman, A. H., and coauthors. 2010. Homing and spawning site selection by supplemented hatchery- and natural-origin Yakima River spring Chinook salmon. Transactions of the American Fisheries Society 139(4):1014-1028.

Dittman, A. H., and T. P. Quinn. 2008. Assessment of the Effects of the Yakima Basin Storage Study on Columbia River Fish Proximate to the Proposed Intake Locations. A component

of Yakima River Basin Water Storage Feasibility Study, Washington. Technical Series No. TS-YSS-13. U.S. Department of the Interior, Denver, Colorado. 179p.
Dittmer, K. 2013. Changing streamflow on Columbia basin tribal lands—climate change and salmon. Climatic Change 120:627–641.
Dunnigan, J. L. 1999. Feasibility and Risks of Coho Reintroduction to Mid-Columbia Tributaries: 1999 Annual Report. Project number 1996-040-00. BPA, Portland, Oregon. 61p.
Edmands, S. 2007. Between a rock and a hard place: Evaluating the relative risks of inbreeding and outbreeding for conservation and management. Molecular Ecology 16:463-475.
Emmons, C. K., M. B. Hanson, and M. O. Lammers. 2019. Monitoring the occurrence of Southern resident killer whales, other marine mammals, and anthropogenic sound in the Pacific Northwest. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-17-MP-4C419. 25 February 2019. 28p.
Fiumera, A. C., B. A. Porter, G. Looney, M. A. Asmussen, and J. C. Avise. 2004. Maximizing offspring production while maintaining genetic diversity in supplemental breeding programs of highly fecund managed species. Conservation Biology 18(1):94-101.
Flagg, T. A., C. V. W. Mahnken, and R. N. Iwamoto. 2004. Conservation hatchery protocols for Pacific salmon. AFS Symposium 44:603-619.
Fletcher, D. H., F. Haw, and P. K. Bergman. 1987. Retention of coded-wire tags implanted into cheek musculature of largemouth bass. North American Journal of Fisheries Management 7:436-439.
Ford, J. K. B., and G. M. Ellis. 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. Marine Ecology Progress Series 316:185–199.
Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. Vancouver, British Columbia, UBC Press, 2nd Edition.
Ford, M., A. Murdoch, and S. Howard. 2012. Early male maturity explains a negative correlation in reproductive success between hatchery-spawned salmon and their naturally spawning progeny. Conservation Letters 5:450-458.
Ford, M. J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16(3):815-825.
Ford, M. J., and coauthors. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. November 2011. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-113. 307p.
Ford, M. J., and coauthors. 2016. Estimation of a killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. PLoS ONE 11(1):1-14.
Foster, R. W. 2004. Letter to Interested Parties from Robert Foster (NMFS). February 3, 2004. Developing the Hatchery and Genetic Management Plans (HGMPs) for Columbia River Basin Anadromous Fish Propagation Programs. NMFS, Portland, Oregon. 3p.
Fukushima, M., T. J. Quinn, and W. W. Smoker. 1998. Estimation of eggs lost from superimposed pink salmon (*Oncorhynchus gorbuscha*) redds. Canadian Journal of Fisheries and Aquatic Sciences 55:618-625.
Fulton, L. A., and R. E. Pearson. 1981. Transplantation and Homing Experiments on salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, in the Columbia River System:

Fish of the 1939-44 broods. July 1981. NOAA Technical Memorandum NMFS F/NWC-12. 109p.
Galbreath, P. F., and coauthors. 2008. Recommendations for Broad Scale Monitoring to Evaluate the Effects of Hatchery Supplementation on the Fitness of Natural Salmon and Steelhead Populations. October 9, 2008. Final report of the Ad Hoc Supplementation Monitoring and Evaluation Workgroup (AHSWG). 87p.
Gharrett, A. J., and S. M. Shirley. 1985. A genetic examination of spawning methodology in a salmon hatchery. Aquaculture 47:245-256.
Gjerde, B., and T. Refstie. 1988. The effect of fin-clipping on growth rate, survival and sexual maturity of rainbow trout. Aquaculture 73(1-4):383-389.
Goodman, D. 2005. Selection equilibrium for hatchery and wild spawning fitness in integrated breeding programs. Canadian Journal of Fisheries and Aquatic Sciences 62(2):374-389.
Grant County PUD, WDFW, Yakama Nation, and USFWS. 2009a. Upper Columbia River Spring-run Chinook Salmon - White River Supplementation Program. September 15, 2009. Spring Chinook Salmon *Oncorhynchus tshawyscha*, Wenatchee Watershed, Upper Columbia Region HGMP.
Grant County PUD, WDFW, and YN. 2009b. Upper Columbia River Spring-run Chinook Salmon, Nason Creek Supplementation Program HGMP. September 15, 2009. 98p.
Grant, W. S. 1997. Genetic Effects of Straying of Non-Native Hatchery Fish into Natural Populations. Proceedings of the workshop, June 1-2, 1995, Seattle, Washington. U.S. Department of Commerce, NOAA Tech. Memo., NMFS-NWFSC-30. 157p.
Gresh, T., J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the Northeast Pacific Ecosystem: Evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest Fisheries Habitat. Fisheries 25(1):15-21.
Hager, R. C., and R. E. Noble. 1976. Relation of size at release of hatchery-reared coho salmon to age, size, and sex composition of returning adults. The Progressive Fish-Culturist 38(3):144-147.
Hanson, M. B., and coauthors. 2010. Species and stock identification of prey consumed by endangered Southern Resident Killer Whales in their summer range. Endangered Species Research 11 (1):69-82.
Hanson, M. B., and C. K. Emmons. 2010. Annual Residency Patterns of Southern Resident Killer Whales in the Inland Waters of Washington and British Columbia. Revised Draft - 30 October 10. 11p.
Hanson, M. B., C. K. Emmons, E. J. Ward, J. A. Nystuen, and M. O. Lammers. 2013. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders. The Journal of the Acoustical Society of America 134(5):3486–3495.
Hanson, M. B., E. J. Ward, C. K. Emmons, and M. M. Holt. 2018. Modeling the occurrence of endangered killer whales near a U.S. Navy Training Range in Washington State using satellite-tag locations to improve acoustic detection data. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-17-MP-4C419. 8 January 2018. 41p.
Hanson, M. B., E. J. Ward, C. K. Emmons, M. M. Holt, and D. M. Holzer. 2017. Assessing the movements and occurrence of Southern Resident Killer Whales relative to the U.S. Navy's Northwest Training Range Complex in the Pacific Northwest. Prepared for: U.S.

Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-15-MP-4C363. 30 June 2017. 32p.

Hard, J. J., and W. R. Heard. 1999. Analysis of straying variation in Alaskan hatchery Chinook salmon (*Oncorhynchus tshawytscha*) following transplantation. Canadian Journal of Fisheries and Aquatic Sciences 56:578- 589.

Hard, J. J., R.P. Jones Jr., M. R. Delarm, and R. S. Waples. 1992. Pacific Salmon and Artificial Propagation under the Endangered Species Act. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-2. 64p.

Hargreaves, N. B., and R. J. LeBrasseur. 1986. Size selectivity of coho (*Oncorhynchus kisutch*) preying on juvenile chum salmon (*O. keta*). Canadian Journal of Fisheries and Aquatic Science 43:581-586.

Hartman, G. F., and J. C. Scrivener. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Canadian Bulletin of Fisheries and Aquatic Sciences 223. 80p.

Hawkins, S. 1998. Residual Hatchery Smolt Impact Study: Wild Fall Chinook Mortality 1995-97. Columbia River Progress Report #98-8. WDFW, Vancouver, Washington. 24p.

Hawkins, S. W., and J. M. Tipping. 1999. Predation by juvenile hatchery salmonids on wild fall Chinook salmon fry in the Lewis River, Washington. California Fish and Game 85(3):124-129.

Healey, M. C. 1991. Life History of Chinook Salmon (*Oncorhynchus tshawytscha*). *In* C. Groot and L. Margolis (eds.), Life history of Pacific Salmon, pages 311-393. University of British Columbia Press. Vancouver, B.C. 89p.

Hess, M. A., and coauthors. 2012. Supportive breeding boosts natural population abundance with minimal negative impacts on fitness of a wild population of Chinook salmon. Molecular Ecology 21:5236-5250.

HETT. 2014. NTTOC.accdb. (database for NTTOC simulations). Douglas County Public Utility District ftp site.

Hillman, T., and coauthors. 2016. Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs. 2015 Annual Report, September 1, 2016. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, Washington. 804p.

Hillman, T., and coauthors. 2017. Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs: 2016 Annual Report, September 15, 2017. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, Washington. 834p.

Hillman, T. W., and J. W. Mullan. 1989. Effect of Hatchery Releases on the Abundance of Wild Juvenile Salmonids. Chapter 8 *in* Summer and Winter Ecology of Juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Report to Chelan County PUD by D.W. Chapman Consultants, Inc. Boise, Idaho. 22p.

Hoar, W. S. 1976. Smolt transformation: Evolution, behavior and physiology. Journal of the Fisheries Research Board of Canada 33:1233-1252.

Hockersmith, E. E., W. D. Muir, S. G. Smith, and B. P. Sandford. 2000. Comparative performance of sham radio-tagged and PIT-tagged juvenile salmon. Report to U.S. Army Corps of Engineers, Contract W66Qkz91521282. 25p.

Holtby, L. B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and associated impacts on the coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 45:502-515.

Horner, N. J. 1978. Survival, Densities and Behavior of Salmonid Fry in Stream in Relation to Fish Predation. July 1978. A Master's Thesis, University of Idaho, Moscow, Idaho. 132p.
Howe, N. R., and P. R. Hoyt. 1982. Mortality of juvenile brown shrimp Penaeus aztecus associated with streamer tags. Transactions of the American Fisheries Society 111(3):317-325.
HSRG. 2004. Hatchery reform: Principles and Recommendations of the Hatchery Scientific Review Group. April 2004. Available at Long Live the Kings. 329p.
HSRG. 2009. Columbia River Hatchery Reform System-Wide Report. February 2009. Prepared by Hatchery Scientific Review Group. 278p.
HSRG. 2014. On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. June 2014, (updated October 2014). 160p.
ICTRT. 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review draft. March 2007. 93p.
ICTRT. 2008. Current status reviews: Interior Columbia Basin salmon ESUs and steelhead DPSs. Vol. 2. Upper Columbia spring Chinook salmon ESU and upper Columbia River steelhead DPS. 167p.
IHOT. 1995. Policies and procedures for Columbia basin anadromous salmonid hatcheries. Annual report 1994 to Bonneville Power Administration, project No. 199204300, (BPA Report DOE/BP-60629). Bonneville Power Administration.
ISAB. 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. May 11, 2007. Report ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon. 146p
Johnston, N. T., C. J. Perrin, P. A. Slaney, and B. R. Ward. 1990. Increased juvenile salmonid growth by whole-river fertilization. Canadian Journal of Fisheries and Aquatic Sciences 47:862-872.
Jones Jr., R. P. 2002. Letter to Interested Parties from Rob Jones (NMFS). Update of Columbia Basin APRE and HGMP Processes. May 31, 2002. NMFS, Portland, Oregon. 4p.
Jones Jr., R. P. 2008. Letter to Jeff Koenings (WDFW) from Rob Jones (NMFS). Review of hatchery programs in the Upper Columbia River. November 13, 2008. NMFS, Portland, Oregon. 11p.
Jones Jr., R. P. 2009. Letter to Interested Parties from Rob Jones (NMFS). Offer of guidance and assistance to ensure hatchery programs in the Upper Columbia River are in compliance with the ESA. February 6, 2009. NMFS, Portland, Oregon. 3p.
Jones, R. 2006. Memo to File - Updates to the salmonid hatchery inventory and effects evaluation report: An evaluation of the effects of artificial propagattion on the status and likelihood of extinction of West Coast salmon and steelhead under the Federal Endangered Species Act. January 19, 2006. NMFS, Portland, Oregon.
Jonsson, B., N. Jonsson, and L. P. Hansen. 2003. Atlantic salmon straying from the River Imsa. Journal of Fish Biology 62:641-657.
Keefer, M. L., and C. C. Caudill. 2014. Homing and straying by anadromous salmonids: a review of mechanisms and rates. Reviews in Fish Biology and Fisheries 24:333-368.
Keefer, M. L., C. C. Caudill, C. A. Peery, and C. T. Boggs. 2008. Non-direct homing behaviours by adult Chinook salmon in a large, multi-stock river system. Journal of Fish Biology 72:27-44.

Kenaston, K. R., R. B. Lindsay, and R. K. Schroeder. 2001. Effect of acclimation on the homing and survival of hatchery winter steelhead. North American Journal of Fisheries Management 21:765-773.

Kline, T. C., Jr., J. J. Goering, O. A. Mathisen, P. H. Poe, and P. L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon: I, δ15N and δ13C evidence in Sashin Creek, Southeastern Alaska. Canadian Journal of Fisheries and Aquatic Sciences 47(1):136-144.

Knudsen, C. M., and coauthors. 2009. Effects of passive integrated transponder tags on smolt-to-adult recruit survival, growth, and behavior of hatchery spring Chinook salmon. North American Journal of Fisheries Management 29:658-669.

Kostow, K. 2009. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries 19:9-31.

Krahn, M. M., and coauthors. 2004. 2004 Status Review of Southern Resident Killer Whales (*Orcinus orca*) under the Endangered Species Act. December 2004. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-62. NMFS, Seattle, Washington. 95p.

Lacy, R. C. 1987. Loss of genetic variation from managed populations: Interacting effects of drift, mutation, immigration, selection, and population subdivision. Conservation Biology 1:143-158.

Lande, R. 1987. Extinction thresholds in demographic models of territorial populations. The American Naturalist 130(4):624-635.

LaPatra, S. E. 2003. The lack of scientific evidence to support the development of effluent limitations guidelines for aquatic animal pathogens Aquaculture 226:191–199.

Larkin, G. A., and P. A. Slaney. 1996. Trends in Marine-Derived Nutrient Sources to South Coastal British Columbia Streams: Impending Implications to Salmonid Production. Report No. 3. Watershed Restoration Program, Ministry of Environment, Lands and Parks and Ministry of Forests. 59p.

Leider, S. A., P. L. Hulett, J. J. Loch, and M. W. Chilcote. 1990. Electrophoretic comparison of the reproductive success of naturally spawning transplanted and wild steelhead trout through the returning adult stage. Aquaculture 88(3-4):239-252.

Lynch, M., and M. O'Hely. 2001. Captive breeding and the genetic fitness of natural populations. Conservation Genetics 2:363-378.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. Pages 217 to 253 (Chapter 6) *in*: Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Climate Impacts Group, University of Washington, Seattle, Washington. 37p.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climate Change 102:187-223.

Martins, E. G., S. G. Hinch, S. J. Cooke, and D. A. Patterson. 2012. Climate effects on growth, phenology, and survival of sockeye salmon (*Oncorhynchus nerka*): a synthesis of the current state of knowledge and future research directions. Reviews in Fish Biology and Fisheries 22(4):887-914.

Matthews, K. R., and R. H. Reavis. 1990. Underwater tagging and visual recapture as a technique for studying movement patterns of rockfish. American Fisheries Society Symposium 7:168-172.

McClelland, E. K., and K. A. Naish. 2007. What is the fitness outcome of crossing unrelated fish populations? A meta-analysis and an evaluation of future research directions. Conservation Genetics 8:397-416.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42. 174p.

McNeil, F. I., and E. J. Crossman. 1979. Fin clips in the evaluation of stocking programs for muskellunge *(Esox masquinongy)*. Transactions of the American Fisheries Society 108:335-343.

Montgomery, D. R., J. M. Buffington, N. P. Peterson, D. Schuett-Hames, and T. P. Quinn. 1996. Stream-bed scour, egg burial depths, and the influecne of salmonid spawning on bed surface mobility and embryo survival. Canadian Journal of Fisheries and Aquatic Sciences 53:1061-1070.

Moring, J. R. 1990. Marking and tagging intertidal fishes: Review of techniques. American Fisheries Society Symposium 7:109-116.

Morrison, J., and D. Zajac. 1987. Histologic effect of coded wire tagging in chum salmon. North American Journal of Fisheries Management 7:439-441.

Morrison, W. E., M. W. Nelson, R. B. Griffis, and J. A. Hare. 2016. Methodology for assessing the vulnerability of marine and anadromous fish stocks in a changing climate. Fisheries 41(7):407-409.

Mote, P. W., and Eric P. Salathé Jr. 2010. Future climate in the Pacific Northwest. Climatic Change 102(1-2):29-50.

Mote, P. W., and coauthors. 2003. Preparing for climatic change: the water, salmon, and forests of the Pacific Northwest. Climatic change 61(1-2):45-88.

Murota, T. 2003. The marine nutrient shadow: A global comparison of anadromous fishery and guano occurrence. Pages 17-31 *in* J.G. Stockner, ed. Nutrients in salmonid ecosystems. American Fisheries Society Symposium 34, Bethesda, Maryland. AFS Symposium 34:17-31.

Myers, J. M., and coauthors. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. February 1998. U.S. Dept. Commer., NOAA Tech Memo., NMFS-NWFSC-35. 476p.

Naish, K. A., and coauthors. 2008. An Evaluation of the Effects of Conservation and Fishery Enhancement Hatcheries on Wild Populations of Salmon Advances in Marine Biology in Advances in Marine Biology, Volume 53. David W. Sims, Series Editor. 318p.

Naman, S. W., and C. S. Sharpe. 2012. Predation by hatchery yearling salmonids on wild subyearling salmonids in the freshwater environment: A review of studies, two case histories, and implications for management. Environmental Biology of Fisheries 94(1):21-28.

Nicola, S. J., and A. J. Cordone. 1973. Effects of fin removal on survival and growth of rainbow trout *(Salmo gairdneri)* in a natural environment. Transactions of the American Fisheries Society 102:753-759.

NMFS. 1994. Biological Opinion for Hatchery Operations in the Columbia River Basin. April 7, 1994. NMFS, Seattle, Washington. 79p.

NMFS. 1995a. Juvenile Fish Screen Criteria. Revised February 16, 1995. NMFS, Portland, Oregon. 15p.

NMFS. 1995b. Proposed Recovery Plan for Snake River Salmon. March 1995. NMFS, Portland, Oregon. 550p.

NMFS. 1996. Juvenile Fish Screen Criteria for Pump Intakes: Addendum. May 9, 1996. NMFS Environmental and Technical Services Division, Portland, Oregon. 4p.

NMFS. 1999. Endangered Species Act Section 7 Consultation Biological Opinion on Artificial Propagation in the Columbia River Basin. Incidental Take of Listed Salmon and Steelhead from Federal and non-Federal Hatchery Programs that Collect, Rear and Release Unlisted Fish Species. March 29, 1999. NMFS Consultation No.: NWR-1999-01903. 231p.

NMFS. 2000a. Endangered Species Act Section 7 Consultation Biological Opinion - Reinitiation of Consultation on Operation of the Federal Columbia River Power System, including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. December 21, 2000. NMFS, Seattle, Washington.

NMFS. 2000b. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. NMFS, Northwest Region, Portland, Oregon.

NMFS. 2003a. Endangered Species Act Section 7 Consultation. Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation. Upper Columbia River (UCR) steelhead (*Oncorhynchus mykiss*), UCR spring Chinook salmon (*O. tshawytscha*). Issuance of an incidental take statement (ITS) to the USFWS; Issuance of an ITS to the BPA and the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation); Issuance of permit 1347 jointly to the Washington Department of Fish and Wildlife (WDFW), the Public Utility District No. 1 of Chelan County (Chelan PUD), and the Public Utility District No. 1 of Douglas County (Douglas PUD). October 22, 2003. NMFS Consultation No.: NWR-1999-01883. 103p.

NMFS. 2003b. National Marine Fisheries Service Section 10(a)(1)(A) permit for take of Endangered/Threatened species. Permit 1395; Direct take (artificial propagation to enhance ESA-listed steelhead). October 2, 2003. Northwest Region, Portland, Oregon. 20p.

NMFS. 2004. Salmonid Hatchery Inventory and Effects Evaluation Report (SHIEER). An Evaluation of the Effects of Artificial Propagation on the Status and Likelihood of Extinction of West Coast Salmon and Steelhead under the Federal Endangered Species Act. Technical Memorandum NMFS-NWR/SWR. May 28, 2004. U.S. Dept. of Commerce, National Marine Fisheries Service, Portland, Oregon. 557p.

NMFS. 2005a. Final assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. NMFS NWR Protected Resources Division, Portland, Oregon. 587p.

NMFS. 2005b. Policy on the consideration of hatchery-origin fish in Endangered Species Act listing determinations for Pacific salmon and steelhead. Pages 37204-37216 *in*. Federal Register, Volume 70 No. 123.

NMFS. 2007. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation. USFWS Artificial Propagation Programs in the Lower Columbia and Middle Columbia River. November 27, 2007. NMFS Consultation No.: NWR-2004-02625. 256p.

NMFS. 2008a. Assessing Benefits and Risks & Recommendations for Operating Hatchery Programs consistent with Conservation and Sustainable Fisheries Mandates. Appendix C of Supplementary Comprehensive Analysis of the Federal Columbia River Power System

and Mainstem Effects of the Upper Snake and other Tributary Actions. May 5, 2008. NMFS, Portland, Oregon.

NMFS. 2008b. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin Subject to the 2008-2017 *U.S. v. Oregon* Management Agreement. May 5, 2008. NMFS, Portland, Oregon. NMFS Consultation No.: NWR-2008-02406. 685p.

NMFS. 2008c. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation: Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order *NWF v. NMFS* Civ. No. CV 01-640-RE (D. Oregon)). May 5, 2008. NMFS, Portland, Oregon. NMFS Consultation No.: NWR-2005-05883. 929p.

NMFS. 2008d. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Seattle, Washington. 251p.

NMFS. 2008e. Section 10(a)(1)(B) 1554 Permit for Takes of Endangered/Threatened Species-Recreational Fisheries for Unlisted Species in the Middle and Upper Columbia River and its Tributaries. 10p.

NMFS. 2008f. Supplemental Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of the Upper Snake and other Tributary Actions. May 5, 2008. NMFS, Portland, Oregon. 1230p.

NMFS. 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. November 30, 2009. NMFS, Portland, Oregon. 260p.

NMFS. 2011. Evaluation of and recommended determination on a Resource Management Plan (RMP), pursuant to the salmon and steelhead 4(d) Rule comprehensive management plan for Puget Sound Chinook: Harvest management component. Salmon Management Division, Northwest Region, Seattle, Washington.

NMFS. 2012. Effects of Hatchery Programs on Salmon and Steelhead Populations: Reference Document for NMFS ESA Hatchery Consultations. December 3, 2012. Northwest Region, Salmon Managment Division, Portland, Oregon. 50p.

NMFS. 2013a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation on issuance of three section 10(a)(1)(A) permits for the Upper Columbia Chiwawa River, Nason Creek, and White River spring Chinook salmon Hatchery Programs. July 3, 2013. NMFS Consultation No.: NWR-2013-9707. NMFS, Portland, Oregon. 145p.

NMFS. 2013b. Endangered Species Act Section 7(a)(2) Biological Opinion, Section 7(a)(2) Not Likely to Adversely Affect Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Entiat National Fish Hatchery Summer Chinook Hatchery Program. April 18, 2013. NMFS Consultation No.: NWR-2012-00841. 79p.

NMFS. 2013c. ESA Recovery Plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. June 2013. 503p.

NMFS. 2015a. ESA Recovery Plan for Snake River Sockeye Salmon (*Oncorhynchus nerka*). June 8, 2015. NMFS, West Coast Region. 431p.

NMFS. 2015b. Proposed ESA Recovery Plan for Snake River Fall Chinook Salmon *(Oncorhynchus tshawytscha*). October 2015. NMFS, West Coast Region, Portland, Oregon. 326p.

NMFS. 2016a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Issuance of a Section 10(a)(1)(A) Permit 18583 for the Upper Columbia Wenatchee River Summer Steelhead Hatchery Program. July 20, 2016. NMFS Consultation No.: WCR-2017-7367. 202p.

NMFS. 2016b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Issuance of Four Section 10(a)(1)(A) Permits for Spring Chinook Salmon Hatchery Programs in the Methow Subbasin. October 13, 2016. NMFS Consultation No.: WCR-2015-3845. 116p.

NMFS. 2016c. Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon (*Oncorhynchus tshawytscha*) & Snake River Steelhead (*Oncorhynchus mykiss*). October 2016. NMFS, Portland, Oregon. 262p.

NMFS. 2017a. Biological Assessment for NMFS' Implementation of the Final Mitchell Act EIS Preferred Alternative and Funding for Operation, Maintenance; and Monitoring, Evaluation and Reform of Columbia River Basin Hatchery Programs. NMFS, West Coast Region, January 2017.

NMFS. 2017b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Four Summer/Fall Chinook Salmon and Two Fall Chinook Salmon Hatchery Programs in the Upper Columbia River Basin. December 26, 2017. NMFS Consultation No.: WCR-2015-3607. 186p.

NMFS. 2017c. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Leavenworth National Fish Hatchery Spring Chinook Salmon Program (Reinitiation 2016). September 29, 2017. NMFS Consultation No.: WCR-2017-7345. 261p.

NMFS. 2017d. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Issuance of a Tribal 4(d) Rule Determination for a Tribal Resource Management Plan (TRMP) submitted by the Confederated Tribes of the Colville Reservation, and Funding and Carrying Out Activities Pursuant to that TRMP. February 24, 2017. NMFS Consultation No.: WCR-2014-388. 129p.

NMFS. 2017e. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. NOAA's National Marine Fisheries Service's implementation of the Mitchell Act Final Environmental Impact Statement preferred alternative and administration of Mitchell Act hatchery funding. January 15, 2017. NMFS Consultation No.: WCR-2014-697. 535p.

NMFS. 2017f. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH)

Consultation. Two Steelhead Hatchery Programs in the Methow River. October 10, 2017. NMFS Consultation No.: WCR-2017-6986. 117p.

NMFS. 2018. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on effects of the 2018-2027 *U.S. v. Oregon* Management Agreement. February 23, 2018. NMFS Consultation No.: WCR-2017-7164. 597p.

NMFS. 2019. Proposed Revision of the Critical Habitat Designation for Southern Resident Killer Whales Draft Biological Report. September 2019. 122p. available online at: https://archive.fisheries.noaa.gov/wcr/publications/protected_species/marine_mammals/killer_whales/CriticalHabitat/0648-bh95_biological_report_september_2019_508.pdf.

NMFS, and ODFW. 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. Final. August 5, 2011. 462p.

NOAA, and WDFW. 2018. Southern Resident Killer Whale Priority Chinook Stocks Report. June 22, 2018. 8p.

Noakes, D. J., R. J. Beamish, and M. L. Kent. 2000. On the decline of Pacific salmon and speculative links to salmon farming in British Columbia. Aquaculture 183:363-386.

NWFSC. 2015. Status Review Update for Pacific Salmon and Steelhead listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. NWFSC, Seattle, Washington. 356p.

NWIFC, and WDFW. 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Revised July 2006. 38p.

O'Neill, S. M., G. M. Ylitalo, and J. E. West. 2014. Energy content of Pacific salmon as prey of northern and Southern Resident Killer Whales. Endangered Species Research 25:265–281.

ODFW. 2003. Fish Health Management Policy, September 12, 2003. Oregon Department of Fish and Wildlife. 10p.

ODFW, and WDFW. 2016. 2016 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and other Species, and Miscellaneous Regulations. January 20, 2016. 101p.

Olla, B. L., M. W. Davis, and C. H. Ryer. 1998. Understanding how the hatchery environment represses or promotes the development of behavioral survival skills. Bulletin of Marine Science 62(2):531-550.

Osborne, R. W. 1999. A historical ecology of Salish Sea "resident" killer whales (*Orcinus orca*): With implications for management. Doctoral dissertation. University of Victoria,Victoria, British Columbia. 277p.

Pastor, S. M. 2004. An evaluation of fresh water recoveries of fish released from national fish hatcheries in the Columbia River basin, and observations of straying. AFS Symposium 44:87-98.

PCIC. 2016. Plan 2 Adapt website, available at https://www.pacificclimate.org/analysis-tools/plan2adapt.

Pearsons, T. N., and C. A. Busack. 2012. PCD Risk 1: A tool for assessing and reducing ecological risks of hatchery operations in freshwater. Environmental Biology of Fishes 94:45-65.

Pearsons, T. N., and A. L. Fritts. 1999. Maximum size of Chinook salmon consumed by juvenile coho salmon. North American Journal of Fisheries Management 19(1):165-170.

Pearsons, T. N., and coauthors. 1994. Yakima River Species Interaction Studies. Annual report 1993. December 1994. Division of Fish and Wildlife, Project No. 1989-105, Bonneville Power Administration, Portland, Oregon. 264p.

Peltz, L., and J. Miller. 1990. Performance of half-length coded wire tags in a pink salmon hatchery marking program. American Fisheries Society Symposium 7:244-252.

PFMC. 2003. Pacific Coast Management Plan. Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the coasts of Washington, Oregon and California as revised through Amendment 14. (Adopted March 1999). September 2003. PFMC, Portland, Oregon. 78p.

Piorkowski, R. J. 1995. Ecological effects of spawning salmon on several south central Alaskan streams. Ph.D. dissertation, University of Alaska, Fairbanks, Alaska. 191p.

PNFHPC. 1989. Model Comprehensive Fish Health Protection Program. Approved September 1989, revised February 2007. PNFHPC, Olympia, Washington. 22p.

Prentice, E. F., T. A. Flagg, and S. McCutcheon. 1987. A Study to Determine the Biological Feasibility of a New Fish Tagging System, 1986-1987. December 1987. Contract DE-AI79-84BP11982, Project 83-319. NMFS, Seattle, Washington. 120p.

Prentice, E. F., and D. L. Park. 1984. A Study to Determine the Biological Feasibility of a New Fish Tagging System, 1983-1984. May 1984. Contract DEA179-83BP11982, Project 83-19. BPA, Portland, Oregon. 44p.

Quamme, D. L., and P. A. Slaney. 2003. The relationship between nutrient concentration and stream insect abundance. American Fisheries Society Symposium 34:163-175.

Quinn, T. P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research 18:29-44.

Quinn, T. P. 1997. Homing, Straying, and Colonization. Genetic Effects of Straying of Non-Native Fish Hatchery Fish into Natural Populations. NOAA Tech. Memo., NMFS-NWFSC-30. 13p.

Quinn, T. P., and N. P. Peterson. 1996. The influence of habitat complexity and fish size on over-winter survival and growth of individually marked juvenile coho salmon (*Oncorhynchus kisutch*) in Big Beef Creek, Washington. Canadian Journal of Fisheries and Aquatic Sciences 53:1555-1564.

Reimchen, T. E., and N. F. Temple. 2003. Hydrodynamic and phylogenetic aspects of the adipose fin in fishes. Canadian Journal of Zoology 82:910-916.

Reisenbichler, R. R., and J. D. McIntyre. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout, *Salmo gairdneri*. Journal of the Fisheries Research Board of Canada 34:123-128.

Rensel, J., and coauthors. 1984. Evaluation of Potential Interaction Effects in the Planning and Selection of Salmonid Enhancement Projects. J. Rensel, and K. Fresh editors. Report prepared by the Species Interaction Work Group for the Enhancement Planning Team for implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. WDFW, Olympia, Washington. 90p.

Richards, S. P., and T. N. Pearsons. 2015. Final Priest Rapids Hatchery Monitoring and Evaluation Annual Report for 2014-15. September 14, 2015. 113p.

Rondorf, D. W., and W. H. Miller. 1994. Identification of the Spawning, Rearing, and Migratory Requirements of Fall Chinook Salmon in the Columbia River Basin. Annual report 1994. Project 9l-029, (Report DOE/BP-21708-4). Bonneville Power Administration, Portland, Oregon.

Ryman, N. 1991. Conservation genetics considerations in fishery management. Journal of Fish Biology 39 (Supplement A):211-224.
Ryman, N., P. E. Jorde, and L. Laikre. 1995. Supportive breeding and variance effective population size. Conservation Biology 9(6):1619-1628.
Ryman, N., and L. Laikre. 1991. Effects of supportive breeding on the genetically effective population size. Conservation Biology 5(3):325-329.
Saisa, M., M.-L. Koljonen, and J. Tahtinen. 2003. Genetic changes in Atlantic salmon stocks since historical times and the effective population size of a long-term captive breeding programme. Conservation Genetics 4:613–627.
Scheuerell, M. D., and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14(6):448-457.
Schnorbus, M., A. Werner, and K. Bennett. 2014. Impacts of climate change in three hydrologic regimes in British Columbia, Canada. Hydrological Processes 28(3):1170–1189.
Sharpe, C. S., D. A. Thompson, H. L. Blankenship, and C. B. Schreck. 1998. Effects of routine handling and tagging procedures on physiological stress responses in juvenile Chinook salmon. The Progressive Fish-Culturist 60(2):81-87.
Sharpe, C. S., P. C. Topping, T. N. Pearsons, J. F. Dixon, and H. J. Fuss. 2008. Predation of Naturally-produced Subyearling Chinook by Hatchery Steelhead Juveniles in Western Washington Rivers. June 2008. FPT 07-09. WDFW Fish Program, Science Division. 68p.
Smith, S. 1999. Letter to Bob Austin (BPA) from Stephen Smith (NMFS). Endangered Species Act (ESA) Consultation on Artificial Propagation Programs in the Columbia River Basin. July 27, 1999. NMFS, Portland, Oregon. 4p.
Snow, C., C. Frady, D. Grundy, B. Goodman, and A. Murdoch. 2016. Monitoring and Evalutation of the Wells Hatchery and Methow Hatchery Programs. 2015 Annual Report. July 1, 2016. Report to Douglas PUD, Grant PUD, Chelan PUD and the Wells and Rocky Reach HCP Hatchery Committees and the Priest Rapids Hatchery Subcommittees, East Wenatchee, Washington. 210p.
Sosiak, A. J., R. G. Randall, and J. A. McKenzie. 1979. Feeding by hatchery-reared and wild Atlantic salmon (*Salmo salar*) parr in streams. Journal of the Fisheries Research Board of Canada 36:1408-1412.
Steward, C. R., and T. C. Bjornn. 1990. Supplementation of Salmon and Steelhead Stocks with Hatchery Fish: A Synthesis of Published Literature. Technical Report 90-1. Idaho Cooperative Fish and Wildlife Research Unit, Moscow, Idaho. 132p.
Tatara, C. P., and B. A. Berejikian. 2012. Mechanisms influencing competition between hatchery and wild juvenile anadromous Pacific salmonids in fresh water and their relative competitive abilities. Environmental Biology of Fishes 94(1):7-19.
Theriault, V., G. R. Moyer, L. S. Jackson, M. S. Blouin, and M. A. Banks. 2011. Reduced reproductive success of hatchery coho salmon in the wild: Insights into most likely mechanisms. Molecular Ecology 20:1860-1869.
Tonseth, M. 2020. Email to Natasha Preston (NMFS) from Michael Tonseth (DFW). Travel time data request. Mar 12, 2020. 2p.
UCSRB. 2007. Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. 352p.
UCSRB. 2014. Upper Columbia Salmon Recovery Board Integrated Recovery Program Habitat Report. June 2014. Wenatchee, Washington. 73p.

USFWS. 1994. Biological Assessments for Operation of USFWS Operated or funded hatcheries in the Columbia River Basin in 1995-1998. Submitted with cover letter dated August 2, 1994, from W.F. Shake, USFWS, to B. Brown, NMFS, Portland, Oregon.

USFWS. 2004. U.S. Fish & Wildlife Service handbook of aquatic animal health procedures and protocols.

USFWS, and NMFS. 1998. Endangered Species consultation handbook procedures for conducting consultation and conference activities under section 7 of the Endangered Species Act. U.S. Fish & Wildlife Service. National Marine Fisheries Service. 315p.

USGCRP. 2009. Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. 196p.

Vander Haegen, G. E., H. L. Blankenship, A. Hoffman, and O. A. Thompson. 2005. The effects of adipose fin clipping and coded wire tagging on the survival and growth of spring Chinook salmon. North American Journal of Fisheries Management 25:1160-1170.

Vasemagi, A., R. Gross, T. Paaver, M. L. Koljonen, and J. Nilsson. 2005. Extensive immigration from compensatory hatchery releases into wild Atlantic salmon population in the Baltic sea: Spatio-temporal analysis over 18 years. Heredity 95(1):76-83.

Vincent-Lang, D. 1993. Relative Survival of Unmarked and Fin-Clipped Coho Salmon from Bear Lake, Alaska. The Progressive Fish-Culturist 55(3):141-148.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. Northwest Science 87(3):219-242.

Walton, R. G. 2008. Letter to Interested Parties, from Rob Walton. NMFS' Intent to Conduct Consultations Under the ESA. September 12, 2008. NMFS, Portland, Oregon. 2p. with attachments.

Walton, R. G. 2010. Letter to Co-managers, Hatchery Operators, and Hatchery Funding Agencies. Development of Hatchery and Harvest Plans for Submittal under the ESA. April 28. 2010. 6p.

Waples, R. S. 1999. Dispelling some myths about hatcheries. Fisheries 24(2):12-21.

Waples, R. S., and C. Do. 1994. Genetic risk associated with supplementation of Pacific salmonids: Captive broodstock programs. Canadian Journal of Fisheries and Aquatic Sciences 51 (Supplement 1):310-329.

Ward, B. R., and P. A. Slaney. 1988. Life history and smolt-to-adult survival of Keogh River steelhead trout (*Salmo gairdneri*) and the relationship to smolt size. Canadian Journal of Fisheries and Aquatic Sciences 45:1110-1122.

WDFW. 2002. 2002 Washington State Salmon and Steelhead Stock Inventory (SASSI). Available on-line at: http://wdfw.wa.gov/fish/sasi/index.htm. Washington Department of Fish and Wildlife, Olympia, Washington. 724p.

WDFW. 2011. 2010-2011 Upper Columbia River Steelhead Fishery ESA Take Report Permit 1395 Final. September 2011. WDFW, Olympia, Washington. 24p.

WDFW. 2012. 2011-2012 Upper Columbia River Steelhead Fishery ESA Take Report Permit 1395 Final. August 2012. WDFW, Olympia, Washington. 28p.

WDFW. 2013. 2012 Annual ESA Take Report for Section 10(a)(1)(B) Permit 1554. April 2013. WDFW, Yakima, Washington. 14p.

WDFW. 2014a. 2013-2014 Upper Columbia River Steelhead Fishery ESA Take Report Permit 1395 Final. August 2014. WDFW, Olympia, Washington. 28p.

WDFW. 2014b. 2013 Annual ESA Take Report for Section 10(a)(1)(B) Permit 1554. April 2014. WDFW, Epharta, Washington. 14p.

WDFW. 2015a. 2014-2015 Upper Columbia River Steelhead Fishery ESA Take Report Final for Section 10(a)(1)(A) Permit 1395. August 2015. WDFW, Olympia, Washington. 31p.
WDFW. 2015b. 2014 Annual ESA Take Report For Section 10(a)(1)(B) Permit 1554. April 2015. WDFW, Ephrata, Washington. 14p.
WDFW. 2016a. 2015-2016 Upper Columbia River Steelhead Fishery ESA Take Report Permit 1395 Final. September 2016. WDFW, Olympia, Washington. 33p.
WDFW. 2016b. 2015 Annual ESA Take Report For Section 10(a)(1)(B) Permit 1554. April 2016. WDFW, Ephrata, Washington. 15p.
WDFW. 2017a. 2016 Annual ESA Take Report for Section 10(a)(1)(B) Permit 1554. April 2017. WDFW, Ephrata, Washington. 17p.
WDFW. 2017b. UCR unlisted programs_Fish Health Record Compilation-2014-2017 December 13, 2017 excel report.
WDFW. 2019. Wells Hatchery Summer Chinook Program for Southern Resident Orca Recovery and Support HGMP. Upper Columbia River Summer Chinook (*Oncorhynchus tshawytscha*). WDFW, Olympia, Washington. October 9, 2019. 46p.
WDFW, and ODFW. 2017. 2017 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. September 7, 2017. 75p.
Westley, P. A. H., T. P. Quinn, and A. H. Dittman. 2013. Rates of straying by hatchery-produced Pacific salmon (*Oncorhynchus* spp.) and steelhead (*Oncorhynchus mykiss*) differ among species, life history types, and populations. Canadian Journal of Fisheries and Aquatic Sciences 70:735-746.
Whitlock, M. C. 2000. Fixation of new alleles and the extinction of small populations: Drift, load, beneficial alleles, and sexual selection. Evolution 54(6):1855-1861.
Wiles, G. J. 2004. Washington State Status Report for the Killer Whale. March 2004. WDFW, Olympia, Washington. 120p.
Willard, C. 2017. Email to Emi Kondo (NMFS) from Catherine Willard (CPUD). November 22, 2017. Unidentified Chinook encounter at Chelan Falls Trap. 4p.
Willi, Y., J. V. Buskirk, and A. A. Hoffmann. 2006. Limits to the adaptive potential of small populations. Annual Review of Ecology, Evolution, and Systematics 37:433-458.
Williamson, K. S., A. R. Murdoch, T. N. Pearsons, E. J. Ward, and M. J. Ford. 2010. Factors influencing the relative fitness of hatchery and wild spring Chinook (*Oncorhynchus tshawytscha*) in the Wenatchee River, Washington. Canadian Journal of Fisheries and Aquatic Sciences 67:1840-1851.
Wipfli, M. S., J. P. Hudson, J. P. Caouette, and D. T. Chaloner. 2003. Marine subsidies in freshwater ecosystems: salmon carcasses increase growth rates of stream-resident salmonids. Transactions of the American Fisheries Society 132:371-381.
Withler, R. E. 1988. Genetic consequences of fertilizing chinook salmon (*Oncorhynchus tshawytscha*) eggs with pooled milt. Aquaculture 68:15-25.
YKFP. 2008. Klickitat River Anadromous Fisheries Master Plan. Yakima/Klickitat Fisheries Project 1988-115-35. 188p.
Zabel, R. W. 2013. Memo to James Lecky (NMFS) from Richard Zabel (NMFS). January 23, 2013. 2012 Estimation Memo. NWFSC, Seattle, Washington. 75p
Zabel, R. W. 2014a. Memorandum to Donna Wieting (NMFS) from Richard Zabel (NMFS). March 13, 2014. 2013 Estimation Memo. NWFSC, Seattle, Washington. 67p.

Zabel, R. W. 2014b. Memorandum to Donna Wieting (NMFS) from Richard Zabel (NMFS). November 4, 2014. 2014 Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2014. NWFSC, Seattle, Washington. 73p.

Zabel, R. W. 2015. Memorandum to Donna Wieting (NMFS) from Richard Zabel (NMFS). Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2015. October 5, 2015. NWFSC, Seattle, Washington. 72p.

Zabel, R. W. 2017. Memorandum to Christopher Yates (NMFS) from Richard Zabel (NMFS). Updated, Corrected Estimation of Percentages for listed Pacific Salmon and Steelhead Smolts Arriving at various locations in the Columbia River Basin in 2016. January 25, 2017. NWFSC, Seattle, Washington. 75p.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.

Zamon, J. E., T. J. Guy, K. Balcomb, and D. Ellifrit. 2007. Winter observations of Southern Resident Killer Whales *(Orcinus orca*) near the Columbia River plume during the 2005 spring Chinook salmon (*Oncorhynchus tshawytscha*) spawning migration. Northwestern Naturalist 88(3):193-198.

# Exhibit 7

Supplemental Environmental Assessment of the Wells Summer Chinook Hatchery and Genetic Management Plan

May 15, 2020

# 1. Introduction

This Supplemental Environmental Assessment (Supplemental EA) supplements the *2019 Environmental Assessment for Endangered Species Act Section 4(d) Approval and Section 10(a)(1)(A) Permit Issuance for Steelhead Hatchery Programs and Section 10(a)(1)(B) Permit Issuance for Summer/Fall and Fall Chinook Salmon Hatchery Programs in Upper Columbia River* (2019 EA) (NMFS 2019). NMFS is proposing to approve an additional 1,000,000 subyearling summer Chinook salmon from the Wells Hatchery under limit 5 of the 4(d) Rule of the Endangered Species Act (ESA). The Washington Department of Fish and Wildlife and Douglas County Public Utility District have submitted a Hatchery and Genetic Management Plan (HGMP) that outlines the supportive breeding, rearing, releasing, and associated monitoring and evaluation actions for the proposed hatchery program (WDFW 2019). The primary purpose of the proposed hatchery program is to augment the prey base of Southern Resident killer whale (SRKW).

This Supplemental EA expands upon the range of alternatives analyzed and may be used in future years. This Supplemental EA relies largely on the background information and analysis contained in the 2019 EA as no significant changes have occurred in the status of the Water Quantity, Water Quality, Salmon and Steelhead, Other Fish Species, Wildlife, Socioeconomics, Cultural Resources, Environmental Justice, and Human Health and Safety (i.e., the affected environment and baseline conditions remain the same). The 2019 EA analyzed a full range of alternatives, including different hatchery production levels. Although the 4(d) approval of the Wells Hatchery program was within the alternatives analyzed, the additional 1,000,000 production was not. The total overall Chinook and steelhead releases covered in the 2019 EA totaled 7,184,135. According to the Mitchell Act FEIS Table 3-11, the Columbia River basin releases total 140,593,000; the Interior Columbia releases total 61,392,000; and the Interior Columbia Chinook releases total 46,174,000 (NMFS 2014).

## 1.1. Proposed Action

The Proposed Action is for NMFS to approve the submitted HGMP (Table 1) under limit 5 of the 4(d) Rule.

**Table 1. Hatchery program included in the Proposed Action**

| Program | Annual release groups | HGMP Receipt | Program Operator | Funding Agencies | Program Type and Purpose | ESA Pathway |
|---|---|---|---|---|---|---|
| Wells Summer Chinook for SRKW[1] | 1.0 million subyearlings[2] | October 9, 2019 | Washington Department of Fish and Wildlife and Douglas PUD[3] | Washington Department of Fish and Wildlife[4] and/or Pacific Salmon Treaty Funds | Segregated Harvest for SRKW recovery and sustainability | 4(d) Limit 5 |

[1]SRKW = Southern Resident Killer Whale
[2] The 1.0M is an "up-to" value depending on funding. For Brood Year 2019, the program is being funded at the 500K production level.
[3]PUD = Public Utility District
[4]This will not include funding for Douglas PUD's normal operating and maintenance costs associated with their existing program obligations. Douglas PUD owns and operates Wells Hatchery.

## 1.2. Proposed Project Area

The Project Area is the geographic area where the Proposed Action would take place. It includes the areas immediately adjoining the hatchery facilities, acclimation sites, and weir locations, as described in the HGMP (WDFW 2019). For this Supplemental EA, the Project Area is the immediate surrounding area of the Wells Hatchery. This Project Area is within the geographic range of the Project Area that was analyzed in the 2019 EA.

## 1.3. Purpose and Need

NMFS proposes to make a determination under the ESA 4(d) Rule for the above-mentioned salmon hatchery program in the Upper Columbia River (UCR) basin. NMFS' purpose is to ensure the sustainability of UCR salmon and steelhead by conserving their productivity, abundance, diversity, and distribution and to meet the applicants' need to have their proposed hatchery program reviewed under the ESA.

## 1.4. Background

The 2019 EA provides details about the history of Columbia River hatchery programs as well as this action in relationship to other plans, regulations, agreements, laws, secretarial orders, and executive orders. These details have not changed and are not repeated here.

### 1.4.1. Description of Alternatives

There are four alternatives being considered in this Supplemental EA:

- **Alternative 1**: Under the No Action Alternative, NMFS would not make a determination under the ESA 4(d) Rule; however, NMFS assumes the new hatchery program would, nonetheless, be operated.[1]
- **Alternative 2**: Under the Proposed Action Alternative (Preferred Alternative), NMFS would make a determination that the submitted HGMP meets the criteria of limit 5 of the 4(d) Rule, and the proposed hatchery program would produce up to 1,000,000 Chinook salmon smolts annually.
- **Alternative 3**: Under the Reduced Production Alternative, the hatchery operators would submit a revised HGMP proposing the production of 500,000 Chinook salmon smolts (i.e., a 50 percent reduction), and NMFS would make a determination that the revised HGMP meets the criteria of limit 5 of the 4(d) Rule.
- **Alternative 4**: Under the No Production Alternative, the proposed hatchery program would not be implemented.

## 2. Affected Environment

The affected environment is described in detail in the 2019 EA, and has not changed.

## 3. Environmental Consequences

### 3.1. Direct and Indirect Impacts of Alternatives 1, 2, 3, and 4

When describing environmental consequences, we compare Alternative 1 to the current environmental conditions and Alternatives 2, 3, and 4 to Alternative 1. Most of the consequences of the Wells summer Chinook hatchery program evaluated in this Supplemental EA were determined to have a negligible-adverse effect compared to Alternative 1 (Table 2). Negligible-beneficial and low-beneficial effects compared to Alternative 1 were the next most common designations (Table 2). These observations are similar to the impacts identified in the 2019 EA. We have footnoted where in Table 2 any effects are different from what was described in the 2019 EA. We have also described additional details on the impacts to Salmon and Steelhead, the resource where some impacts have changed. Because the environmental consequences of this Supplemental EA and the 2019 EA are largely the same, we have not repeated the justification here.

**Table 2. Summary of the effects of the proposed hatchery program on the nine resources evaluated in this Supplemental EA.**

| Resource | Effect | Species | Alternative 1 No-action | Effects of Alternative Relative to No-action | | |
|---|---|---|---|---|---|---|
| | | | | 2 | 3 | 4 |
| Water Quantity | NA | NA | Low-adverse | Same as Alt.1 | Negligible-beneficial | Negligible-beneficial |
| Water Quality | NA | NA | Low-adverse | Same as Alt.1 | Same as Alt.1 | Negligible-beneficial |

[1] The operators have indicated that this new program may not operate if they do not have ESA 4(d) authorization. However, we describe this scenario under Alternative 4.

| Resource | Effect | Species | Alternative 1 No-action | Effects of Alternative Relative to No-action | | |
|---|---|---|---|---|---|---|
| | | | | 2 | 3 | 4 |
| Salmon and Steelhead | Genetics | Spring Chinook Salmon | Undetectable | Same as Alt.1 | Same as Alt.1 | Same as Alt.1 |
| | | Steelhead | Undetectable[1] | Same as Alt.1 | Same as Alt.1 | Same as Alt.1[1] |
| | Competition and Predation | Spring Chinook salmon | Low-adverse | Same as Alt.1 | Negligible-benefit | Low-beneficial |
| | | Steelhead | Negligible-adverse[1] | Same as Alt.1 | Low-beneficial | Low-beneficial |
| | | Summer/Fall Chinook salmon | Negligible-adverse | Same as Alt.1 | Low-beneficial | Low-beneficial |
| | | Sockeye salmon | Negligible-adverse | Same as Alt.1 | Same as Alt.1 | Same as Alt. 1 |
| | | Coho salmon | Negligible-adverse | Same as Alt.1 | Same as Alt.1 | Low-beneficial |
| | Diseases | All (see Salmon and Steelhead) | Negligible-adverse | Same as Alt.1 | Same as Alt.1 | Same as Alt.1 |
| | Population Viability | UCR Spring Chinook Salmon | Negligible-adverse | Same as Alt.1 | Same as Alt.1 | Low-beneficial |
| | | UCR Steelhead | Negligible-adverse[1] | Same as Alt.1 | Same as Alt.1 | Low-beneficial |
| | Nutrient Cycling | All (see Salmon and Steelhead) | Low-beneficial | Same as Alt.1 | Negligible-adverse | Low-adverse |
| | Facility Operations | All (see Salmon and Steelhead) | Undetectable[1] | Same as Alt.1 | Same as Alt.1 | Same as Alt.1 |
| | Research, Monitoring, and Evaluation | All (see Salmon and Steelhead) | Undetectable[1] | Same as Alt.1 | Same as Alt.1 | Same as Alt.1 |
| Other Fish Species | Competition and predation | See Table 13 | Negligible-adverse | Same as Alt.1 | Negligible-beneficial | Negligible-beneficial |
| | Prey enhancement | See Table 13 | Negligible-beneficial | Same as Alt.1 | Negligible-adverse | Negligible-adverse |
| | Disease | See Table 13 | Negligible-adverse | Same as Alt.1 | Negligible-beneficial | Negligible-beneficial |
| | Nutrient cycling | See Table 13 | Negligible-beneficial | Same as Alt.1 | Negligible-adverse | Negligible-adverse |
| | Facility operations | See Table 13 | Negligible-adverse | Same as Alt.1 | Same as Alt.1 | Negligible-beneficial |

| Resource | Effect | Species | Alternative 1 No-action | Effects of Alternative Relative to No-action | | |
|---|---|---|---|---|---|---|
| | | | | 2 | 3 | 4 |
| Wildlife | Competition and predation | See Section 3.5 | Undetectable | Same as Alt.1 | Same as Alt.1 | Negligible-adverse |
| | Prey enhancement | See Section 3.5 | Negligible-beneficial | Same as Alt.1 | Negligible-adverse | Negligible-adverse |
| | Disease | See Section 3.5 | Negligible-adverse | Same as Alt.1 | Undetectable | Negligible-beneficial |
| | Nutrient cycling | See Section 3.5 | Low-beneficial | Same as Alt.1 | Negligible-adverse | Negligible-adverse |
| | Facility operations | See Section 3.5 | Negligible-adverse | Same as Alt.1 | Negligible-adverse | Negligible-beneficial |
| Socioeconomics | NA | NA | Medium-beneficial | Same as Alt.1 | Negligible-adverse | Negligible-adverse |
| Cultural | NA | NA | Low-beneficial | Same as Alt.1 | Low-adverse | Medium-adverse |
| Environmental Justice | NA | NA | Medium-beneficial | Same as Alt.1 | Negligible-adverse | Low-adverse |
| Human Health and Safety | NA | NA | Low-adverse | Same as Alt.1 | Same as Alt.1 | Low-beneficial |

[1]See justification in the Salmon and Steelhead, Section 3.1.1

### 3.1.1. Salmon and Steelhead

Fish released from hatchery program can interact with natural-origin salmon and steelhead and their habitat through a variety of effects. Not all of these effects may occur through the hatchery program being analyzed in this Supplemental EA. In this section, the hatchery program effects under each alternative on natural salmon and steelhead populations in the Analysis Area are discussed and evaluated.

In the UCR, the Spring Chinook Salmon Evolutionary Significant Unit (ESU) [64 FR 14308, reaffirmed in 2005 (70 FR 37160) and in 2014 (79 FR 20802)] is listed as endangered. The UCR Steelhead distinct population segment (DPS) was originally listed as endangered (62 FR 43937), but in 2009, was downlisted to threatened (74 FR 42605, and reaffirmed in 2014 (79 FR 20802)). The listings for both species include natural- and hatchery-origin fish. The designated critical habitat for both species includes portions of the Methow Basin, Wenatchee Basin, and the Columbia River (70 FR 52630).

**Other populations**

The non-ESA-listed salmon and steelhead populations in the action area are Okanogan, Methow, Entiat, and Wenatchee summer/fall Chinook salmon, Okanogan and Wenatchee sockeye salmon, and coho salmon that are being reintroduced into the Methow and Wenatchee basins through the Mid-Columbia Coho Restoration program (NMFS 2014a).

Please see tables 3-6 and 3-7 in the 2019 EA for a full description of other fish and wildlife species that may interact with salmon and steelhead in the action area.

#### 3.1.1.1. Genetics

The UCR Spring Chinook Salmon ESU and UCR Steelhead DPS could experience an increased risk of genetic impacts resulting from the Proposed Action. Therefore, the effects on the UCR Spring Chinook Salmon ESU and Steelhead DPS are analyzed in this subsection.

Summer Chinook salmon in general are not likely to interbreed with spring Chinook salmon (or steelhead) because they are generally separated in space and time of spawning. While summer Chinook salmon adults returning from the hatchery program have a high likelihood of interbreeding with naturally produced summer Chinook salmon in the UCR, the genetic risk is considered relatively low because pHOS has been low in almost all spawning areas under the current operations and pHOS goals (mean of ~5% recovery of hatchery-origin adults on spawning grounds) (Hillman et al. 2017; Richards and Pearsons 2015; Snow et al. 2017). As such, we predict that a 20% increase in the size of the hatchery program would have an undetectable genetic effect on the UCR spring or summer Chinook salmon and steelhead.

Under Alternative 2, the operation of the hatchery program would be the same as under Alternative 1, with no change in effects on natural spring Chinook salmon or steelhead genetics. Therefore, this alternative would also have the same undetectable effects for the Steelhead DPS and Spring Chinook Salmon ESU as Alternative 1. Under Alternative 3, a reduction of 50 percent of the summer Chinook released would most likely have the same undetectable effect on the UCR spring Chinook salmon ESU and Steelhead DPS for the reasons discussed above. Moreover, summer Chinook salmon do not spawn at the same time or area as spring Chinook salmon or steelhead, and reducing the number of returning hatchery fish will continue to have an undetectable effect on population genetic diversity. Under Alternative 4, the new hatchery program is not implemented and therefore there would be no detectable genetic effects from the program.

#### 3.1.1.2. Competition and Predation

Under Alternative 1, the hatchery program would be operated. The competition and predation effects would be:

- Low-adverse for spring Chinook salmon. The potential effect of the hatchery releases of summer Chinook salmon on juvenile spring Chinook salmon would most likely be greater in the mainstem Columbia River in the Analysis Area than the tributaries because fish are released directly to the Columbia River Interaction between hatchery- and natural-origin juveniles in the tributaries is very unlikely because fish are released in the mainstem Columbia River and juvenile spring Chinook salmon could be migrating at the same time in the same areas as hatchery fish after release, meaning possible overlap for interactions through competition or predation. According to the PCD risk model used in the accompanying Biological Opinion, 32 Chinook and 1 steelhead adult equivalent maybe lost to competition interactions from juvenile hatchery fish competing with

natural-origin fish. No fish would be expected to be lost due to predation effects. Adult summer Chinook salmon returning from the hatchery program are not likely to compete for spawning sites, but may potentially superimpose redds; however, the overlap in time and space is not believed to be at a level of concern.

- Negligible-adverse for steelhead. It is not likely that juveniles released from the hatchery program will compete with naturally rearing steelhead because of how fast they migrate out of the streams where released. Adult hatchery summer/fall Chinook salmon are not thought to negatively interact with steelhead in any discernible way.
- Negligible-adverse for summer Chinook salmon. Newly emerged summer and fall Chinook salmon fry would be vulnerable as prey to migrating smolts that are released from the hatchery program. However, in general, during the smolt migration, most of the smolts in the mainstem Columbia River migrate in the bulk of the flow and the water clarity is reduced from snow melt, making predation potentially less likely. Summer and fall Chinook fry have been found to stay close to shoreline habitats until after the spring run-off and would be less likely to have spatial overlap with migrating smolts. Returning adult summer Chinook salmon overlap with natural-origin summer and fall Chinook salmon on the spawning grounds and may superimpose redds. Because the populations of summer and fall Chinook salmon in the UCR generally have a low demographic risk, the effects of some of the redds being superimposed is considered negligible. There is most likely some effect from competition and/or predation of hatchery summer Chinook on newly emerged summer and fall Chinook salmon.
- Negligible-adverse for sockeye salmon. Interactions between hatchery juveniles and sockeye smolts would occur in the mainstem Columbia River while emigrating to the ocean Interaction is likely minor. In their review of the same hatchery program, NMFS (2017) used a model to determine the effects of competition and predation from the hatchery summer Chinook salmon released; the model results suggest that there is limited effect on sockeye salmon within the mainstem Columbia River to McNary Dam. Since sockeye stage before spawning in lakes, and spawn at different times than the hatchery-origin returning adults in spawning areas upstream of summer Chinook salmon, the interaction between adult sockeye and returning adult fish from the hatchery program is not likely.
- Negligible-adverse for coho salmon. The smolts from the hatchery program may have spatial and temporal overlap with naturally rearing coho salmon in the maintstem Columbia River to McNary Dam. Hatchery fish are released into the mainstem Columbia River, therefore it is likely that some predation and competition occurs between hatchery juveniles and coho juveniles. Adult competition for spawning grounds and redd superimpositions are not likely to occur because of the difference in spawning time, and location for summer Chinook salmon.

Under Alternative 2, the operation of the hatchery program would be the same as under Alternative 1, with no change in release numbers and thus competition and predation effects on other salmon and steelhead species would remain the same. Therefore, this alternative would have the same effects as Alternative 1. Under Alternative 3, the effects of the hatchery program would be somewhat lower than under Alternative 1. The hatchery program would operate with production reduced 50 percent compared to Alternative 1. The competitive and predatory effects

of hatchery smolts would be reduced compared to Alternative 1, and the competitive effects of hatchery-origin adults are likely to be reduced compared to Alternative 1. Under Alternative 4, the hatchery program would not operate. Because there would be no summer Chinook salmon hatchery-origin smolts or adults, the competitive and predatory effects of the hatchery fish would eventually subside, although hatchery fish from other programs would still be interacting with natural-origin fish. Therefore, the effects would be low-beneficial to all species relative to Alternative 1.

### 3.1.1.3. Disease

Under Alternative 1, the hatchery program would be operated. No detections of exotic pathogens have occurred in recent years at the hatchery being evaluated in this Supplemental EA. Diseases that have occurred are caused by endemic pathogens, and hatchery operations would continue to use available treatments to keep these outbreaks in check. Therefore, all salmon and steelhead discussed here are negligibly-adversely affected. Under Alternative 2, the operation of the hatchery program would be the same as under Alternative 1, with no change in disease effects on other salmon and steelhead species. Therefore, this alternative would also have the same, negligible-adverse effect as Alternative 1 on all salmon and steelhead being evaluated in this EA. Under Alternative 3, the effects of the hatchery program would be the same as under Alternative 1. The program would operate with production reduced 50 percent compared to Alternative 1. However, the hatchery would continue to operate for other programs that would have similar disease effects on natural salmon and steelhead species. Therefore, this alternative would also have the same, negligible-adverse effect as Alternative 1 for all species. Under Alternative 4, the hatchery program would be terminated immediately. However, those facilities would continue to operate for other programs (e.g., spring Chinook salmon, coho salmon) and could have some disease effects on natural salmon and steelhead species. Therefore, this alternative would also have the same, negligible-adverse effect as Alternative 1 for all species.

### 3.1.1.4. Population Viability

The discussion here is limited to UCR Spring Chinook Salmon ESU and UCR Summer Steelhead DPS because these are the only species that have established population viability criteria. Under Alternative 1, the hatchery program would release the same number of smolts as under current conditions. The population viability would be:

- Negligible-adverse for the UCR Spring Chinook Salmon ESU and Steelhead DPS. The potential adverse impacts from the hatchery program on the spring Chinook salmon ESU would be the potential for redd superimposition from hatchery-origin summer Chinook salmon. Furthermore, the hatchery program may have some impacts on natural-origin juvenile spring Chinook salmon and steelhead through competition with hatchery juvenile summer Chinook salmon. These interactions have the potential to affect abundance and productivity of natural-origin spring Chinook salmon and Steelhead. However, since the likelihood for redd superimposition and competition is low because of differences in spawning time and location, the effect of the hatchery program on the spring Chinook salmon ESU and Steelhead DPS is negligible-adverse.

Under Alternative 2, the operation of the hatchery program would be the same as under Alternative 1, with no change in population viability of UCR Spring Chinook Salmon ESU and UCR Steelhead DPS compared to Alternative 1. Therefore, this alternative would also have the same effect as Alternative 1 (i.e., negligible-adverse effect for UCR Spring Chinook Salmon ESU and low-beneficial effect for UCR Steelhead DPS). Under Alternative 3, the hatchery program would release 50 percent of the current production levels. The effect on the UCR Spring Chinook Salmon ESU and Steelhead DPS would be the same as Alternative 1 (negligible-adverse). Under Alternative 4, the hatchery program would be terminated immediately. Relative to Alternative 1, the population viability effects would be low-beneficial for UCR Spring Chinook Salmon ESU and Steelhead DPS. Since the current hatchery releases are negligible-adverse on the viability of the UCR Spring Chinook Salmon ESU, the designation for eliminating the program should improve population viability, although there is some potential that productivity may decrease because of less ocean-derived nutrients being available.

#### 3.1.1.5. Nutrient Cycling

Under Alternative 1, the hatchery program would be operated. All the salmon and steelhead discussed here currently benefit from additional nutrient provided by the hatchery fish carcasses. Because summer Chinook hatchery-origin fish die after spawning naturally, the program provides a low-beneficial effect on salmon and steelhead that exist in the spawning streams through nutrient cycling. Under Alternative 2, the operation of the hatchery program would be the same as under Alternative 1, with no change in nutrient cycling effects on other salmon and steelhead. Therefore, this alternative would also have the same low-beneficial effect as Alternative 1. Under Alternative 3, the effects of the hatchery program would be slightly less as those under Alternative 1 because the hatchery program would operate with production reduced 50 percent compared to Alternative 1. This would mean that there would be fewer hatchery fish on the spawning grounds, and therefore, this alternative would have a negligible-adverse effect compared to Alternative 1, with change in effects smaller than under Alternative 4. Under Alternative 4, the hatchery program would be terminated immediately. Because hatchery-origin fish from the program would no longer be present on the spawning grounds, other salmon and steelhead would no longer benefit from nutrients provided to the environment by the hatchery carcasses. Therefore, termination of the hatchery program would have low-adverse effects on nutrient cycling for other salmon and steelhead relative to Alternative 1.

#### 3.1.1.6. Facility Operations

Under Alternative 1, the hatchery program would be operated the same as under current conditions as described in the 2019 EA because the hatchery facility would continue operating regardless of the additional proposed hatchery program. Termination of the program would not result in termination of the hatchery facility. For these reasons, we would expect undetectable effects under Alternatives 1, 2, 4, and 4 from this current program.

#### 3.1.1.7. Research, Monitoring, and Evaluation (RM&E)

RM&E would continue to operate regardless of the proposed hatchery program (i.e. no new activities are being proposed compared to what was described in the 2019 EA). Therefore, we

would expect undetectable effects under Alternatives 1, 2, 3, and 4 from this current hatchery program.

## 4. Cumulative Impacts

The expected impacts of the alternatives on all of the resources are described in Section 3, Environmental Consequences. Section 3 does not take into account future foreseeable actions, especially in the context of future climate change. This section considers impacts that may occur as a result of any one of the alternatives being implemented at the same time as other anticipated future actions and presents information in the context of future climate change. The cumulative impacts described in the 2019 EA apply to this Supplemental EA. Past, Present, and Reasonably Foreseeable Actions; Geographic and Temporal Scales; and Climate Change have not changed and are not repeated here. Moreover, the effects analysis has not changed substantially from the 2019 EA. Below, we describe cumulative impacts on the resources where effects as described in Section 3, Environmental Consequences, have changed since the 2019 EA.

### 4.1. Salmon and Steelhead

The expected direct and indirect effects of the alternatives on salmon and steelhead are described in Section 3, Environmental Consequences. The past actions as well as the current and future actions are the same as those described in the 2019 EA and are, therefore, not repeated here. These past, current, and future actions are also described extensively in the Mitchell Act EIS (NMFS 2104). In summary, past actions, such as land use practices from agriculture, livestock, and land development have reduced floodplain connectivity and riparian function and cover. Climate change in the Columbia River Basin may reduce the abundance and productivity of salmon and steelhead populations through the following mechanisms:

- Increased mortality may occur due to more frequent flood flows, changed thermal regime during incubation, and lower disease resistance
- Warmer winters would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limited
- Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival

Changing environmental conditions are also likely to occur as a result of development and habitat restoration programs.

#### 4.1.1. Alternative 1

The effects of the proposed hatchery program on salmon and steelhead have been discussed in Section 3. Considering the cumulative effects of past, present, and future actions and conditions, the release of hatchery fish from the program evaluated in this EA is not expected to be a major limiting factor negatively affecting the viability of salmon and steelhead in the UCR.

While the Wells summer Chinook releases in this Supplemental EA were not included in the Mitchell Act FEIS, we can infer similar results to another summer Chinook hatchery program out of Wells Hatchery. This is because the hatchery operations are identical for this new program, and the releases are similar in size to the subyearling and yearling summer Chinook programs already being operated at the Wells Hatchery (804,000 total released compared to 1M).

#### 4.1.2. Alternative 2

Under Alternative 2, the effects would be the same as under Alternative 1.

#### 4.1.3. Alternative 3

Under Alternative 3, the release numbers of fish would be reduced by 50 percent. While all populations of salmon and steelhead in the UCR have been affected to some degree by legacy effects (fisheries, dams, agriculture, and land use development) and will be affected in the future from these continued effects and the effects of climate change, the cumulative impact of this alternative depends on the specific population of natural fish in the subbasin or area where hatchery fish are released. Therefore, in summary, the overall effect of this alternative would be negligible.

#### 4.1.4. Alternative 4

Under Alternative 4, the hatchery program evaluated in this EA would not be operated. As stated above, all populations of salmon and steelhead in the UCR have been effected to some degree by legacy effects (fisheries, dams, agriculture, and land use development) and will continue to be affected in the future from these effects, as well as those from other hatchery productions and climate change. Therefore, in summary, this alternative would probably have a minor demographic risk to summer Chinook salmon because most of the natural populations are already meeting abundance targets set by the state. Impacts to other populations of salmon and steelhead in the UCR would most likely be minimal.

## 5. Applicable Mandates: Federal Laws and Executive Orders

The applicable mandates are described in the 2019 EA and are not repeated here.

## 6. List of Preparers and Persons and Agencies Consulted

Natasha Preston
NOAA National Marine Fisheries Service
West Coast Region
Sustainable Fisheries Division

## 7. REFERENCES CITED

Hillman, T., and coauthors. 2017. Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery Programs: 2016 Annual Report, September 15, 2017. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, Washington. 834p.

NMFS. 2014. Final Environmental Impact Statement to inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs. West Coast Region. National Marine Fisheries Service. Portland, Oregon.

NMFS. 2017. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Four Summer/Fall Chinook Salmon and Two Fall Chinook Salmon Hatchery Programs in the Upper Columbia River Basin. December 26, 2017. NMFS Consultation No.: WCR-2015-3607. 186p.

NMFS. 2019. Environmental Assessment for Endangered Species Act Section 4(d) Approval and Section 10(a)(1)(A) Permit Issuance for Steelhead Hatchery Programs and Section 10(a)(1)(B) Permits Issuance for Summer/Fall and Fall Chinook Salmon Hatchery Programs in Upper Columbia River Basin Final Environmental Assessment. June 2019. 134p.

Richards, S. P., and T. N. Pearsons. 2015. Final Priest Rapids Hatchery Monitoring and Evaluation Annual Report for 2014-15. September 14, 2015. 113p.

Snow, C., C. Frady, D. Grundy, B. Goodman, and A. Haukenes. 2017. Final Monitoring and Evaluation of the Wells Hatchery and Methow Hatchery Programs. 2016 Annual Report. November 15, 2017. Report to Douglas PUD, Grant PUD, Chelan PUD, and the Wells and Rocky Reach HCP Hatchery Committees, and the Priest rapids Hatchery Subcommittees, East Wenatchee, Washington. 210p.

WDFW. 2019. Wells Hatchery Summer Chinook Program for Southern Resident Orca Recovery and Support HGMP. Upper Columbia River Summer Chinook (*Oncorhynchus tshawytscha*). WDFW, Olympia, Washington. October 9, 2019. 46p.

# Exhibit 8

# 1. FINDING OF NO SIGNIFICANT IMPACT

## 1.1. Background

### 1.1.1. Proposed Action:

The Proposed Action is for the National Marine Fisheries Service (NMFS) to make an Endangered Species Act (ESA) determination under limit 5 of the 4(d) Rule for Washington Department of Fish and Wildlife (WDFW) and Douglas Public Utility District's (PUD) Wells Summer Chinook Salmon Hatchery Program for Southern Resident killer whales (SRKW). See the attached Supplemental Environmental Assessment (Supplemental EA) on the Proposed Action for more details (Attachment A).

### 1.1.2. Alternatives Evaluated in the Environmental Assessment:

There were four alternatives considered in the Supplemental EA:

- **Alternative 1**: Under the "No Action Alternative," NMFS would not make a determination under the ESA 4(d) Rule; however, NMFS assumes the new hatchery program would, nonetheless, be operated.[1]
- **Alternative 2**: Under the "Proposed Action Alternative" (Preferred Alternative), NMFS would make a determination that the submitted Hatchery Genetic and Management Plan (HGMP) meets the criteria of limit 5 of the 4(d) Rule, and the proposed hatchery program would produce up to 1,000,000 summer Chinook salmon smolts annually.
- **Alternative 3**: Under the "Reduced Production Alternative," the hatchery operators would submit a revised HGMP proposing the production of 500,000 summer Chinook salmon smolts (i.e., a 50 percent reduction), and NMFS would make a determination that the revised HGMP meets the criteria of limit 5 of the 4(d) Rule.
- **Alternative 4**: Under the "No Production Alternative," the proposed hatchery program would not be implemented.

### 1.1.3. Selected Alternative:

NMFS is choosing Alternative 2 (Proposed Action/Preferred Alternative), under which NMFS will make a determination that the submitted HGMP meets the criteria of limit 5 of the 4(d) Rule, and the proposed hatchery program will produce up to 1,000,000 summer Chinook salmon smolts annually.

## 1.2. Related Consultations:

Past ESA and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) consultations related to the Proposed Action are described in NMFS' 2019 EA (NMFS 2019) and Supplemental EA (Attachment A). In addition, two new ESA consultations were completed on the Proposed Action in 2020:

[1] The operators have indicated that this new program may not operate if they do not have ESA 4(d) authorization. However, we describe this scenario under Alternative 4.

- NMFS determined that the proposed HGMP is not likely to jeopardize the continued existence or recovery of ESA-listed salmon and steelhead in the Columbia River Basin (NMFS 2020).
- NMFS determined that the proposed HGMP would not adversely affect ESA-listed bull trout, and the United States Fish and Wildlife Service (USFWS) concurred (USFWS 2020).

### 1.3. Significance Review

The Council on Environmental Quality (CEQ) Regulations state that the determination of significance using an analysis of effects requires examination of both context and intensity, and lists ten criteria for intensity (40 C.F.R. § 1508.27). In addition, the Companion Manual for National Oceanic and Atmospheric Administration Administrative Order 216-6A provides sixteen criteria, the same ten as the CEQ Regulations and six additional, for determining whether the impacts of a Proposed Action are significant. Each criterion is discussed below with respect to the Proposed Action and considered individually as well as in combination with the others.

***1. Can the Proposed Action reasonably be expected to cause both beneficial and adverse impacts that overall may result in a significant effect, even if the effect will be beneficial?***

Response: NMFS' determination for ESA coverage for the Wells summer Chinook salmon hatchery program for SRKW analyzed in the attached Supplemental EA is not reasonably expected to cause beneficial or adverse impacts that overall may result in a significant effect. This conclusion pertains to both the overall impacts of the action as well as to the specific impacts to various resources considered. The Supplemental EA identified nine resources that the Proposed Action may impact and categorized the magnitude of the potential impact from low (adverse) to medium (beneficial). Impacts that were determined to be no more than low-adverse include: hatchery operations on water quality and quantity, predation and competition through the interaction of hatchery-origin and natural-origin Upper Columbia River (UCR) spring Chinook salmon juveniles throughout the analysis area, and the impacts to human health and safety. The other identified resource impacts fall to the lower end of the relative magnitude spectrum, within the negligible to undetectable ranges.

The Proposed Action is expected to benefit the recovery and sustainability efforts for the SRKW distinct population segment (DPS) by way of increasing adult Chinook salmon returns and potentially providing a cultural and local economic benefit to fisheries in the UCR Basin by augmenting available catchable fish for recreational and tribal fisheries. In addition, these activities are monitored and controlled by regulations that minimize negative impacts on the biological and physical components of the environment while promoting benefits to the human component. See Section 4 of the Supplemental EA, for detailed information of the potential impacts.

***2. Can the Proposed Action reasonably be expected to significantly affect public health or safety?***

Response: The Proposed Action is expected to have a low-adverse impact to public health or safety, directly or indirectly. Hatchery facility operations associated with the Proposed Action

are implemented in compliance with state and Federal safety regulations and environmental laws, thus reducing potential risks to public health. The public will have limited exposure to hatchery facility operations. Any known potential impacts to public health as a result of the Proposed Action is limited to the willful consumption of hatchery-origin fish, which is directly associated with the frequency of consuming fish regardless of whether fish are of hatchery or natural-origin.

3. ***Can the Proposed Action reasonably be expected to result in significant impacts to unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?***

Response: The Proposed Action is not expected to induce more than low-adverse impacts on unique geographic areas, such as proximity to historic or cultural resources, park land, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas because no new infrastructure is proposed through the action.

NMFS and USFWS found that the Proposed Action is not likely to destroy or adversely modify any ESA-designated critical habitats for ESA-listed UCR spring Chinook salmon, UCR steelhead, and bull trout within the analysis area (USFWS 2020). The habitat impacts analyzed in the Supplemental EA are determined to be no more than low-adverse under the Proposed Action. For more information, see the Supplemental EA, subsection 4.1, Salmon and Steelhead.

4. ***Are the Proposed Action's effects on the quality of the human environment likely to be highly controversial?***

Response: The Proposed Action's effects on the quality of the human environment are not likely to be highly controversial because the impacts of these hatchery programs, as identified in the Supplemental EA, are similar to the implementation of hatchery programs over prior years, for which NMFS reached the same conclusion (NMFS 2019). Moreover, NMFS has provided an opportunity for public comment on the HGMP. In response, NMFS received one set of comments raising general concerns about threats to the Columbia River ecosystem and did not identify any aspects of the Proposed Action as highly controversial. The impacts associated with the Proposed Action are well-studied and well-understood, and no significant opposition has been raised.

5. ***Are the Proposed Action's effects on the human environment likely to be highly uncertain or involve unique or unknown risks?***

Response: The Proposed Action's effects on the human environment are not likely to be highly uncertain or involve unique or unknown risks. No unique or substantially unknown risks have been identified. Numerous scientific studies on hatchery risks have identified what NMFS considers an accurate list of potential concerns. As with most hatchery programs there is some degree of uncertainty as to how well the hatchery programs would be able to achieve goals stated in the HGMPs. However, from past experience NMFS can determine an approximate risk level associated with the Proposed Action and steps to further contain that risk. The Proposed Action includes explicit steps to monitor and evaluate uncertainties in a manner that allows timely

adjustment to risks that might arise. NMFS retains the ability, through its regulations, to require changes if the program is determined to be ineffective, particularly with respect to the control of genetic effects on salmon and steelhead. Finally, numerous actions described in the hatchery program are already in place and have demonstrated their effectiveness, at least initially, reducing the level of uncertainty.

***6. Can the Proposed Action reasonably be expected to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?***

Response: The Proposed Action is not likely to establish a precedent for future actions with significant effects or to represent a decision in principle about a future consideration. Other hatchery operations in the UCR Basin have been analyzed through similar ESA analyses and National Environmental Policy Review (NEPA) reviews, so this action and the analysis thereof is not unique. Moreover, we do not consider any hatchery program a precedent for another one as each program has unique characteristics and risks involved.

***7. Is the Proposed Action related to other actions that when considered together will have individually insignificant but cumulatively significant impacts?***

Response: NMFS is well aware of the possibility that hatchery practices in one basin may not be likely to raise significant impacts on their own, but that the totality of hatchery operations in the UCR Basin could give rise to cumulatively significant impacts. Therefore, NMFS has completed environmental impact statements (EISs) on hatchery operations across the Basin (NMFS 2014; NMFS 2017) which can be relied upon to both disclose the significant impacts of hatcheries on a broad scale and to consider whether the Proposed Action itself could give rise to cumulatively significant impacts when added to the impacts of other hatcheries across the region. For this analysis, NMFS has incorporated the Mitchell Act Final EIS (NMFS 2014) into the analysis, and cumulative impacts of the Proposed Action have been considered in the Supplemental EA (Attachment A) and in the associated ESA section 7 consultation biological opinion (NMFS 2020). The take of ESA-listed salmon and steelhead is small enough to result in a no-jeopardy ESA determination when considering all existing conditions, all other permits, and other actions in the area affecting these conditions and permits. These hatchery programs are coordinated with monitoring so that hatchery managers can respond to changes in the status of affected listed species. If the cumulative impacts of salmon management efforts fail to provide for recovery of listed species, then discussions would occur and potential adjustments to the hatchery production levels may be proposed through consultations between the program operators and NMFS.

The Proposed Action is related to other hatchery production programs in that many are guided by the same legal agreements, mitigation responsibilities, and managed by the same agencies. While direct and indirect impacts of the Proposed Action are not expected to be measurable outside the project area, it is also important to consider how impacts of certain activities outside the project area may or may not interact with the Proposed Action in such a way that impacts on resources are exacerbated.

The 2019 EA relied on the cumulative impacts considerations in the Mitchell Act Final EIS for overall guidance, and then compared the potential cumulative effects of the Proposed Action

(section 5) added to the cumulative effects of the operation of all the hatchery programs in the Columbia River Basin (NMFS 2014; NMFS 2017).

***8. Can the Proposed Action reasonably be expected to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources?***

Response: The Proposed Action does not include any new construction and is, therefore, unlikely to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places. Accordingly, it is equally unlikely that the Proposed Action may cause loss or destruction of significant scientific, cultural, or historic resources because of the limited geographic scope of the project area, which includes none of the aforementioned structures or resources. In addition, the Proposed Action would produce salmon, which are culturally important to the tribes.

***9. Can the Proposed Action reasonably be expected to have a significant impact on endangered or threatened species, or their critical habitat as defined under the Endangered Species Act of 1973?***

Response: The degree to which the Proposed Action adversely impacts endangered or threatened species, or their critical habitat, as described in the Supplemental EA, will be no more than low-adverse. In the Supplemental EA, NMFS took into account the analysis performed in ESA biological opinion completed on the proposed hatchery program that determined that the program will not reduce appreciably the likelihood of survival and recovery of the two ESA-listed species within the action area, and therefore concluded the UCR Spring Chinook Salmon Evolutionarily Significant Unit (ESU) and the UCR Steelhead DPS will not be jeopardized (NMFS 2020).

The Supplemental EA (Attachment A) and biological opinion (NMFS 2020) also summarize the impacts of the Proposed Action on ESA-designated critical habitat. Both concluded that the expected impacts on critical habitat for endangered or threatened species from the activities associated with the hatchery program (such as maintenance of facilities and instream structures) are unlikely to adversely modify or destroy critical habitat elements.

The Supplemental EA also analyzed impacts on bull trout. An ESA section 7 informal consultation was completed by USFWS on incidental impacts of the proposed hatchery programs on ESA-listed bull trout. The USFWS concurred with NMFS and concluded that the effects of the proposed hatchery programs may affect, but not likely to adversely affect bull trout and its designated critical habitat (USFWS 2020).

***10. Can the Proposed Action reasonably be expected to threaten a violation of Federal, state, or local law or requirements imposed for environmental protection?***

Response: The Proposed Action is not expected to threaten any violations of Federal, state, or local laws or requirements imposed for environmental protection. No regulatory violations or other significant environmental impacts are expected to result from the Proposed Action. The

Proposed Action is also specifically designed to comply with the ESA and is part of the purpose of the action.

Hatchery operations are required to comply with the Clean Water Act, including obtaining and operating within the limit of National Pollutant Discharge Elimination System (NPDES) permits for discharge from hatchery facilities. Acclimation facilities without NPDES permit requirements discharge at a minimal level, as to not need a NPDES permit.

***11. Can the Proposed Action reasonably be expected to significantly adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act?***

Response: The Proposed Action is not expected to adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act. Direct impacts on marine mammals are not likely because marine mammals are not present in the UCR Basin. Minimal indirect impacts on marine mammals may occur, as the hatchery-origin Chinook salmon from the UCR Basin released into the Columbia River provide a potential food source benefits for the marine mammals inhabiting the pelagic zones off the coast of Washington and Oregon along with pinniped populations located in the lower portions of the Lower Columbia River Basin and Columbia River Estuary. The Proposed Action affects marine mammal prey availability in two ways: by producing fish that marine mammals can feed on and by reducing the number of natural-origin fish that would ultimately be available to the whales as prey. However, we believe this adverse effect is minimal on natural-origin fish and do not expect the Proposed Action to significantly adversely affect stocks of marine mammals as defined under the Marine Mammal Protection Act.

***12. Can the Proposed Action reasonably be expected to significantly adversely affect managed fish species?***

Response: The Proposed Action is not expected to affect managed fish species beyond what NMFS identifies as low-adverse. The impacts of the Proposed Action on managed fish species, specifically salmon, steelhead, and bull trout, within the UCR Basin are limited to the ecological impacts of intra and inter-species competition and predation related to the release of juveniles and the direct effects on target and non-target species due to broodstock collection activities. Any and all effects to managed fish within the project area related to the Proposed Action have been analyzed in NMFS' biological opinion (NMFS 2020) and USFWS' Letter of Concurrence (USFWS 2020). See the biological opinion and Letter of Concurrence for further details on the impacts of the Proposed Action to managed species.

***13. Can the Proposed Action reasonably be expected to significantly adversely affect essential fish habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act?***

Response: The Proposed Action was found to have no adverse effects on EFH, as defined under the Magnuson-Stevens Fishery Conservation and Management Act (NMFS 2020). The activities described in the HGMPs, such as maintenance of intake structures, are unlikely to remove or destroy habitat elements. These activities do not include any construction or habitat modification and, therefore, do not affect EFH necessary for these species to carry out spawning, breeding, feeding, or growth to maturity.

The return of hatchery-origin UCR summer Chinook salmon produced by the hatchery program is likely to have a positive effect on water quality related to marine-derived nutrients because the additional returns from hatchery production will result in a net increase of marine-derived nutrients in the project area.

***14. Can the Proposed Action reasonably be expected to significantly adversely affect vulnerable marine or coastal ecosystems, including but not limited to, deep coral ecosystems?***

Response: The Proposed Action is not expected to have an adverse effect on vulnerable marine or coastal ecosystems, including but not limited to, deep coral ecosystem because any meaningful or discernible effects would be limited to the affected environment (i.e., the UCR Basin) which does not extend to the marine environment. The Proposed Action is expected to have a low-adverse impact to Pacific salmon EFH, but the associated impacts due to the Proposed Action are anticipated to only take place within the Columbia River Basin and, therefore, will not affect vulnerable marine or coastal ecosystems.

***15. Can the Proposed Action reasonably be expected to significantly adversely affect biodiversity or ecosystem functioning (e.g., benthic productivity, predator-prey relationships, etc.)?***

Response: The Proposed Action is expected to have no more than a low-adverse effect on biodiversity or ecosystem functions within the affected environment. The hatchery programs may result in small improvements to benthic productivity through increased deposits of marine-derived nutrients resulting from returning hatchery-origin adult carcasses to the watersheds post-spawning. Although summer Chinook salmon produced in the hatchery program is expected to compete with other fish species in the project area, predation is not expected in large quantities since juvenile hatchery-origin salmon generally migrate through the action area quickly after being released (see subsection 4.4.3, Competition and Predation). Hatchery-origin summer Chinook salmon produced in the hatchery program may also provide a prey base for other predatory species (see subsection 4.4.3, Competition and Predation), but the program represents only a small portion of the total amount of food available to predator species. Therefore, the Proposed Action is not expected to have significant impacts on biodiversity and ecosystem function.

***16. Can the Proposed Action reasonably be expected to result in the introduction or spread of a nonindigenous species?***

Response: The Proposed Action is not reasonably expected to result in the introduction or spread of nonindigenous species because the Proposed Action has no potential to cause the transport, release, propagation, or spread of non-indigenous species. The Proposed Action involves the operation of hatchery facilities for the purpose of artificial propagation of salmonids in the UCR Basin for the recovery and sustainability of SRKW. The artificial propagation program uses returning hatchery UCR summer Chinook salmon adults as broodstock and, therefore, will not introduce nonindigenous species to the project area.

### 1.4. Determination

In view of the information presented in this document, the analysis contained in NMFS' 2019 EA (NMFS 2019), and the analysis in the attached Supplemental EA, it is hereby determined that NMFS' determination that the Wells Summer Chinook Salmon HGMP meets the criteria of limit 5 of the 4(d) Rule will not significantly impact the quality of the human environment. In addition, all beneficial and adverse impacts of the Proposed Action have been addressed to reach the conclusion of no significant impacts. Accordingly, preparation of an environmental impact statement for this action is not necessary.

Barry A. Thom
Regional Administrator
NMFS West Coast Region

May 14, 2020
Date

## 2. References Cited

NMFS. 2014. Final Environmental Impact Statement to inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs. West Coast Region. National Marine Fisheries Service. Portland, Oregon.

NMFS. 2017. Final Environmental Impact Statement and record of decision for *U.S. v. Oregon*. November 6, 2017. NMFS, Portland, Oregon. 420p.

NMFS. 2019. Environmental Assessment for Endangered Species Act Section 4(d) Approval and Section 10(a)(1)(A) Permit Issuance for Steelhead Hatchery Programs and Section 10(a)(1)(B) Permits Issuance for Summer/Fall and Fall Chinook Salmon Hatchery Programs in Upper Columbia River Basin Final Environmental Assessment. June 2019. 134p.

NMFS. 2020. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation Wells Summer Chinook Hatchery Program for Southern Resident Killer Whales NMFS Consultation No.: WCR0-2020-00825. May 11, 2020. 112p.

USFWS. 2020. Letter to Allyson Purcell (NMFS) from Brad Thompson (USFWS). Letter of Concurrence. March 31, 2020. 7p.

# Exhibit 9

# Record of Decision for the Final Environmental Impact Statement for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin

## I. Introduction and Background

This Record of Decision (ROD) was developed by the National Marine Fisheries Service (NMFS) in compliance with decision-making requirements, pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (40 CFR 1505.2). The purpose of this ROD is to document NMFS' decision regarding the project.

This ROD is designed to: (1) state NMFS' decision and present the rationale for that decision; (2) identify the alternatives considered in the final Environmental Impact Statement (EIS) in reaching the decision; and (3) state whether all practicable means to avoid or minimize environmental harm from implementation of the selected alternative have been adopted, and if not, why they were not (40 C.F.R. § 1505.2).

The Washington Department of Fish and Wildlife (WDFW), Muckleshoot Indian Tribe, and Suquamish Tribe (hereafter referred to as the co-managers) jointly submitted hatchery and genetic management plans (HGMPs) for 10 hatchery programs that would produce salmon and steelhead in the Duwamish-Green River Basin in Puget Sound. NMFS is the federal agency responsible for administering the Endangered Species Act (ESA) for Chinook salmon (Puget Sound evolutionary significant unit [ESU]), chum salmon (Hood Canal summer run ESU), and steelhead (Puget Sound distinct population segment [DPS]), which are listed as threatened under the ESA. NMFS' ESA §4(d) regulations allow the co-managers to apply for a take exemption for the operation of their hatchery programs which affect ESA-listed salmon and steelhead. The proposed action is NMFS' determination that the co-managers' HGMPs meet the requirements of Limit 5 (artificial propagation) and Limit 6 (joint state/tribal plans under U.S. v. Oregon or U.S. v. Washington settlement processes) of the 4(d) Rule. The HGMPs for the co-managers' hatcheries would be exempt from the take prohibitions of the ESA regarding threatened salmon and steelhead, and the programs would continue to be implemented by the co-managers.

## II. Alternatives Considered

### Alternative 1 (No Action)

Under Alternative 1, the no-action alternative, NMFS would not make a determination under the 4(d) Rule for any of the 10 HGMPs, and the hatchery programs would not be exempted from ESA section 9 take prohibitions. Although other outcomes are possible, for the purposes of this EIS, NMFS has defined the No-action Alternative as the choice by the applicants to continue the hatchery programs without ESA authorization and to potentially change hatchery production levels at any time. The three new Fish Restoration Facility (FRF) programs would produce up to 1,550,000 juveniles. Up to 13,993,000 salmon and steelhead juveniles would be released from the 10 hatchery programs annually. No new environmental protection or enhancement measures would be implemented.

**Alternative 2 (Proposed Action)**
Under Alternative 2, NMFS would make a determination that the HGMPs submitted by the co-managers meet the requirements of the 4(d) Rule. The salmon and steelhead hatchery programs in the Duwamish-Green River Basin would be implemented as described in the 10 submitted HGMPs, and, as under Alternative 1, up to 13,993,000 salmon and steelhead juveniles would be released annually. The hatchery programs would use hatchery capacity as described in the HGMPs for operations and would be adaptively managed over time to incorporate best management practices as new information is available.

**Alternative 3 (Termination)**
Under Alternative 3, NMFS would make a determination that the HGMPs as proposed do not meet the standards prescribed under Limit 5 and Limit 6 of the 4(d) Rule, and the 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin would be terminated. All salmon and steelhead being raised in hatchery facilities (i.e., fall-run Chinook salmon, late winter-run steelhead, summer-run steelhead, coho salmon, and chum salmon) would be released or killed, and no broodstock would be collected. No hatchery fish would be produced or released from the 10 hatchery programs.

**Alternative 4 (Reduced Production)**
Under Alternative 4, the applicants would reduce the number of fish released from each of the 10 proposed hatchery programs by 50 percent (to 6,996,500 salmon and steelhead juveniles) because it represents a mid-point between the proposed action (Alternative 2) and termination of the hatchery programs (Alternative 3). Revised HGMPs would be submitted reflecting these reduced production levels, and NMFS would make a determination that the revised HGMPs submitted as an RMP meet the requirements of the 4(d) Rule.

**Alternative 5 (Increased Production/Preferred Alternative)**
Under this alternative, the applicants would use existing facility capacity to increase the number of fall-run Chinook salmon subyearlings produced by the Soos Creek fall-run Chinook salmon hatchery program. The number of Soos Creek fall-run Chinook salmon subyearlings produced would be 6,200,000 fish, which is 2,000,000 more subyearlings than under Alternative 1 and Alternative 2. Furthermore, the 2,000,000 subyearlings would be released from Palmer Pond, in addition to the 1,000,000 subyearlings that would be released from Palmer Pond under Alternative 1 and Alternative 2, the total maximum release level would be 15,915,000 hatchery-origin salmon and steelhead. Alternative 5 also includes changes in steelhead release levels. The Green River late winter-run steelhead hatchery program would increase by 22,000 yearlings to 55,000, and the FRF late winter-run steelhead hatchery program would decrease by 100,000 yearlings to 250,000, resulting in a net decrease of 78,000 steelhead yearlings as compared to Alternative 1 and Alternative 2.

## III. Public Involvement

NMFS formally initiated environmental review of the project through a Notice of Intent (NOI) to prepare an EIS in the Federal Resister on May 4, 2016. This NOI announced a 30-day public scoping period, during which other agencies, tribes, and the public were invited to provide comments and suggestions regarding issues and alternatives to be included in the EIS. NMFS developed a website for the EIS at http://www.westcoast.fisheries.noaa.gov/hatcheries/salmon_and_steelhead_hatcheries.html. The website was available during the scoping and was updated and available throughout the project duration. Notifications of the public scoping process were distributed in emails to a list of over 4,200 addresses that had been compiled from people that commented on earlier hatchery EISs. Electronic and other notifications were sent to agencies, private individuals, businesses, and non-governmental organizations that contained a link to the website for this EIS and the address to the EIS electronic mailbox.

A Draft EIS was subsequently produced and made available for a 45-day review period, announced in the Federal Register on November 3, 2017; the review period was extended another 30 days in response to public requests for an extension. During the comment period, NMFS received two letters from government agencies, one email from a non-governmental organization, and 23 emails from individual citizens. Primary issues raised in the comments related to the finding that the genetic effect of the steelhead hatchery is high, the reliance of Southern Resident Killer Whales on salmon and steelhead as prey, and the impacts to salmon and steelhead from sea lion and seal predation. A Draft Supplemental EIS was issued for an initial 45-day review period, which was extended for an additional 15 days due to the overlap of the comment period with the December 2018 to January 2019 government shutdown. The initial review period for the Draft Supplemental EIS was announced in the Federal Register on December 7, 2018. NMFS received two letters from government agencies and 13 emails from individual citizens. Primary issues raised in the comments related to a need for clarification regarding the benefits of Alternative 5 to Southern Resident Killer Whales, the potential impacts of Alternative 5 on the role of the Duwamish-Green Chinook salmon in the Chinook Salmon Recovery Plan, and clarification on the genetic risks to natural origin Chinook salmon from Alternative 5. Appendix C of the Final EIS contains a summary of the comments received on both draft documents and NMFS' responses, including a description of changes made to the Draft EIS. The last section of the Summary of the FEIS describes the changes that were made to the Draft EIS and Draft Supplemental EIS.

The Final EIS was subsequently produced and made available for a 30-day public review period announced in the Federal Register on July 12, 2019. During the review period, two comment letters were received, with one letter that included substantive comments. Comment letters were received and are summarized in Appendix A of this ROD. A review of the comments revealed that most of the issues had already been raised in public comments on the Draft EIS, and they had been addressed in the preparation of the Final EIS. The rest of the comments were considered during NMFS' decision-making process

## IV. Environmentally Preferable Alternative(s)

NMFS is required by regulation to specify in the ROD "the alternative or alternatives which were considered to be environmentally preferable" (40 CFR 1505.2(b)). The environmentally preferred alternative generally means the alternative that causes the least damage to the biological and physical environment; it also means the alternative that best protects, preserves, and enhances historic, cultural, and natural resources (The Council on Environmental Quality (CEQ), Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18,026 (March 23, 1981). Alternative 5 was identified in the FEIS as the preferred alternative. Alternative 3 would likely result in the least amount of damage to the human environment.

> Alternative 3 evaluated terminating the 10 Duwamish-Green salmon and steelhead hatchery programs. This alternative would result in the least damage to the aquatic environment because water would not be used to raise hatchery fish, hatchery effluent would not be discharged into adjacent streams, and no hatchery fish would be released to create risks associated with genetic effects, competition, predation and disease. However, this alternative would potentially negatively affect certain wildlife species that prey upon hatchery fish, reduce socioeconomic benefits and environmental justice benefits to the human environment from fisheries catching hatchery fish, and decrease ecosystem nutrient benefits from hatchery fish carcasses decomposing in the natural environment.

## V. Results of Consultations

Both NMFS and the U.S. Fish and Wildlife Service (USFWS) conducted Endangered Species Act (ESA) Section 7(a)(2) Biological Opinions on the 10 Hatchery Programs for Salmon and Steelhead in the Duwamish/Green River Basin. NMFS conducted a Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) consultation on the action.

For ESA-listed species, NMFS determined that the action is likely to adversely affect the Puget Sound steelhead DPS and the Puget Sound Chinook salmon ESU but not likely to adversely affect the Hood Canal Summer Chum Salmon ESU nor the Ozette Lake Sockeye Salmon ESU. For all ESUs/DPSs, NMFS determined that the action is not likely to jeopardize the species nor is it likely to destroy or adversely modify critical habitat. The USFWS determined that the action is likely to adversely affect the threatened bull trout as a result of incidental captures during broodstock collection, but that the action is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

There are three federal fishery management plans that describe EFH in the project area: Pacific Coast Salmon, Pacific Coastal Pelagic Species, and Pacific Coast Groundfish. NMFS determined that the action will not have an effect on EFH described in either the Pacific Coastal Pelagic Species or the Pacific Coast Groundfish Fishery Management Plans. The action will have an

adverse effect on EFH described in the Pacific Coast Salmon Fishery Management Plan and EFH conservation recommendations are provided. The Reasonable and Prudent Measures and Terms and Conditions included in the Incidental Take Statement of the ESA Section 7(a)(2) Biological Opinion constitute NMFS' recommendation to address potential EFH effects.

## VI. Mitigation and Monitoring

The CEQ's NEPA regulations require agencies to identify in the ROD whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted and if not, why they were not (40 CFR Part 1505.2(d)). The regulations further state that a monitoring and enforcement program be adopted and implemented, where applicable, for any mitigation. Mitigation includes avoidance, minimization, and reduction of impacts, and compensation for unavoidable impacts. The hatchery programs included in Alternative 5 require both mitigation of hatchery impacts on affected resources and monitoring and evaluation. They are described further below.

The primary reason why NMFS has identified Alternative 5 as the preferred alternative is that NMFS' authority under the 4(d) regulations is limited to reviewing HGMPs as submitted by hatchery operators and making determinations whether they meet the applicable regulatory standards. If NMFS finds that they do, the hatchery programs described in the HGMPs are considered exempt from the take prohibitions of the ESA with respect to threatened salmon and steelhead. As far as making changes to HGMPs for the benefit of salmon and steelhead, NMFS worked cooperatively with hatchery operators to emphasize program design and operations that minimize impacts to threatened salmon prior to the submission of HGMPs for review and throughout the consultation process. Thus, in addition to meeting NMFS' regulatory role, Alternative 5 includes substantive elements that merit the selection as the preferred alternative.

Alternative 5 includes the culmination of hatchery reforms taken since salmon and steelhead were listed to mitigate impacts of all the programs on natural-origin salmon and steelhead. Significant hatchery reforms and mitigation have been implemented, such as changes in release numbers, locations, and life stages to reduce impacts on natural-origin fish.

Under Alternative 5, the proposed HGMPs will apply best management practices to minimize deleterious genetic effects and to ensure high survival of fish in the hatchery by monitoring and evaluation of fish health, implementing necessary precautionary and treatment actions, and releasing smolts that are healthy to reduce risks of pathogen transmission to natural fish, and minimize ecological interactions while emigrating to the ocean. Broodstock collection will occur to minimize impacts on natural-origin salmon and steelhead and reduce domestication selection in the hatchery environment.

Monitoring and evaluation of the hatchery programs included in Alternative 5 will occur annually. The specific details of the monitoring are included in Section 11 (and other applicable

sections) of the HGMPs. Most of the annual monitoring is focused on evaluating the performance of the hatchery program. Evaluating impacts on natural-origin salmon and steelhead from the hatchery programs is focused predominately on measuring hatchery fish on the spawning grounds. In most areas, this basic information is collected on an annual basis. Other genetic and ecological impact studies occur from time to time as funding and the need arises.

The Reasonable and Prudent Measures and Terms and Conditions included in the Incidental Take Statement of the NMFS ESA Section 7(a)(2) Biological Opinion require that 1) the co-managers follow all conditions specified in each authorization issued as well as guidance specifically in the opinion for their respective programs, 2) a workgroup is developed to plan for fish passage and the reintroduction of fish above Howard Hanson Dam, and 3) the co-managers provide annual reports to the Sustainable Fisheries Division for all hatchery programs and associated research, monitoring and evaluation.

The Reasonable and Prudent Measures included in the Incidental Take Statement of the USFWS ESA Section 7(a)(2) Biological Opinion require minimizing and monitoring adverse effects to bull trout associated with steelhead broodstocking and alternative brookstock collection activities, including incidental capture and handling, and genetic tissue removal. The Terms and Conditions specify 1) individuals engaged in broodstock collection be trained in bull trout identification and safe handling procedures, 2) all bull trout are released as soon as possible after genetic sample has been taken, as close as possible to the point of capture, and with a minimum of handling, 3) hooks that penetrate critical areas, such as esophagus and stomach that cannot be removed easily, will be left in the fish with the line being cut as close as possible to the hook, 4) all captured bull trout shall be reported to the USFWS and 5) bull trout mortalities shall be kept whole and put on ice or frozen.

## VII. Decision and Rationale for Decision

As stated above, NMFS has a responsibility to comply with NEPA before making a determination under the ESA on whether the co-managers' jointly submitted HGMPs meet the criteria of Limit 5 and Limit 6 of the 4(d) Rule for listed salmon and steelhead in Puget Sound. NMFS analyzed a range of alternatives and determined that Alternative 5, the Preferred Alternative, meets the criteria for Limit 5 and Limit 6, does not jeopardize ESA-listed salmon or steelhead in Puget Sound, meets the co-managers' objectives for fisheries targeting hatchery-origin salmon and steelhead, and provides additional Chinook salmon that may benefit Southern Resident killer whales (SRKWs). Other alternatives, including the Environmentally Preferable Alternative 3, may reduce impacts to listed and non-listed salmon and steelhead, but do not provide the desired level of recreational, commercial and subsistence fishery benefits for the state of Washington and additional prey resources for SRKW. Furthermore, NMFS' 4(d) regulations do not provide NMFS with the authority to unilaterally order changes of magnitude indicated by Alternative 3 as a condition of approval of the HGMPs. Analysis of this alternative

was provided to assist with a full understanding of potential effects on the environment under various management scenarios.

Alternative 5 was identified by the final EIS as the preferred alternative. This alternative corresponds to NMFS' authority, which consists of providing a determination on whether the HGMPs meet the regulatory standard for approval, and also results in a balance among the affected resources in realizing benefits while minimizing the environmental and social impacts. Alternative 5 allows natural-origin salmon and steelhead to be collected for broodstock integration which will reduce the genetic impacts of these programs on natural-origin salmon and steelhead populations. The operation of the hatchery facilities will affect the adjacent rivers and streams, but the water quantity and water quality impacts are limited in scope and relatively short-lived. The proposed releases of hatchery fish under Alternative 5 reduce impacts on the natural environment compared to the No-action alternative, while providing socioeconomic benefits to recreational and commercial fisheries in the ocean and freshwater, increased salmon and steelhead abundances to meet subsistence and ceremonial needs of Puget Sound treaty tribes, and increased ocean Chinook salmon prey base that may benefit SRKW. Furthermore, the USFWS determined that this action is not likely to result in jeopardy to the bull trout or destruction or adverse modification of bull trout critical habitat

Through the EIS and the documentation in this ROD, NMFS considered the objectives of the proposed action and analyzed a reasonable range of alternatives that adequately address the objectives of the proposed action, and the extent to which the impacts of the action could be mitigated. NMFS also considered public and agency comment received during the EIS scoping and review periods. In balancing the projected effects of the various alternatives presented in the EIS and the public interest with economic, technical, NOAA statutory mandates, and matters of national policy, NMFS has decided to implement Alternative 5. Consequently, NMFS concludes that the approved alternative provides reasonable, practical, and practicable means to avoid, minimize, or compensate for environmental harm from the action.

January 27, 2020
Date

West Coast Region
National Marine Fisheries Service

**Appendix A:**

**Responses to Comments on the FEIS to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed Approval of Hatchery and Genetic Management Plans for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin Pursuant to Section 7 and Section 4(d) of the Endangered Species Act**

Two comment letters were received.

One comment letter from an individual dated July 10, 2019, indicated that hatcheries damage the environment, but this comment does not include any additional details or reference anything specific in the FEIS. This comment is noted, and we refer to the analysis of potential impacts discussed in the FEIS in Section 4 as describing anticipated effects of the Alternatives.

A second comment letter from the EPA dated August 12, 2019 includes three comments that are addressed below.

1) *The EPA recommended that the Final EIS include additional information to support conclusions such as "…it is likely that fish from the hatchery programs form a small but meaningful part of the diet of Southern Resident killer whales." EPA goes on to cite one of the citations provided in the FEIS regarding the finding that Chinook salmon from the south Puget Sound comprise approximately 64% of SRKW diet (NWFSC unpubl. data).*

   As noted in Section 3.4 of the FEIS, prey availability has been identified by NOAA Fisheries (2014) as a major threat to SRKW recovery. Several citations are provided in this section regarding the importance of Chinook salmon in the SRKW diet (e.g. Ford et al. 2016; Chasco et al. 2017a,b). Section 3.4 of the FEIS also notes that Chinook salmon are the most calorie rich salmon species (O'Neill et al. 2014). Further, the FEIS notes that adult hatchery-origin Chinook represent 74 percent of the total Chinook returning to Puget Sound; SRKWs do not distinguish between hatchery-origin and natural-origin Chinook; and adults from hatchery releases have partially compensated for declines in natural-origin salmon and may have benefitted SRKWs (NMFS 2014; Chasco 2017a). Section 3.4 of the FEIS also notes that the contribution of Chinook by the Duwamish-Green hatchery programs is likely small (<2% of total abundance) but there is overlap in time and space with salmon production and SRKWs that can provide localized increases in SRKW prey abundance at specific times. Hanson et al. (2010), cited in Section 3.4, states that 6-14 percent of Chinook salmon prey for SRKWs from May to September originates in Puget Sound, supporting the conclusion in the FEIS that although the Duwamish-Green hatchery programs may make a small contribution to total number of adult Chinook salmon originating from Puget Sound, small increases in prey availability at the proposed location and time of year may provide benefit to SRKWs, which are documented have food limitation as a recovery issue. Thus, the statement regarding

hatchery programs likely forming a small but meaningful part of the diet of SRKWs is well supported by the best available science and the citations included in the FEIS.

2) *The EPA is concerned that the statement regarding Washington Department of Fish and Wildlife's plans to increase hatchery production in watersheds where natural-origin Chinook do not occur has the potential to give the decision-makers and the public the impression that hatchery production increases would only occur in watersheds without natural-origin Chinook salmon populations. EPA recommends that the Record of Decision clarify policies related to reasonably foreseeable hatchery production increases and co-occurrence with natural-origin salmon populations.*

   The sentence concerning increased production that could occur in watersheds without natural-origin Chinook salmon populations was not meant to predict whether or not WDFW could potentially request future increases in production in watersheds with natural-origin Chinook salmon populations, such as the Duwamish-Green watershed.

3) *The EPA recommended the Record of Decision include additional information on how the co-managers will monitor and evaluate the contribution of hatchery production on addressing the endangered SRKW's need for its preferred prey.*

   NMFS anticipates that overall increases in Chinook salmon hatchery production (in the Duwamish-Green watershed and potentially other watersheds) are likely to increase the overall abundance of ocean-stage Chinook salmon that are available as prey to SRKWs. The NMFS/Northwest Fisheries Science Center has active research and monitoring programs for SRKWs that include studies on population dynamics, diet, prey availability, and the impacts of ocean salmon fisheries. We anticipate these studies to continue, and while it may not be possible to determine a direct link between SRKW health and increased hatchery production, the ongoing monitoring will help to inform NMFS whether there are improvements associated with increased production on prey availability and fitness and survival of SRKWs. Co-managers will continue to partner with NMFS to advance our understanding of the effects of increased hatchery production on SRKW health.

# Exhibit 10

# 4(d) Rule Limit 6

## Evaluation and Recommended Determination

| | |
|---|---|
| **Title of RMP:** | Ten Joint Hatchery and Genetic Management Plans for the Duwamish/Green River Basin |
| **RMP Submitted by:** | Washington Department of Fish and Wildlife<br>Muckleshoot Indian Tribe<br>Suquamish Tribe |
| **ESU/DPS:** | Puget Sound Chinook Salmon ESU<br>Puget Sound Steelhead DPS |
| **4(d) Rule Limit:** | Limit 6 |
| **NMFS Tracking Number:** | WCR-2016-4659 |
| **Date:** | January 30, 2020 |

# TABLE OF CONTENTS

# LIST OF TABLES

# 1 EVALUATION

NOAA's National Marine Fisheries Service (NMFS) issued a final Endangered Species Act (ESA) 4(d) Rule adopting regulations necessary and advisable to conserve Puget Sound Chinook salmon (50 CFR 223.203(b); 70 FR 37160, June 28, 2005). These regulations were subsequently applied to the Puget Sound Steelhead Distinct Population Segment (DPS) in a separate final rule (73 FR 55451, June 25, 2008). Under limit 6 of the Rule, ESA section 9 take prohibitions for these listed salmonid species do not apply to hatchery activities that are undertaken in compliance with a resource management plan (RMP) developed jointly by the Tribes and the State of Washington that is consistent with the 4(d) Rule criteria.

Section 9 of the ESA prohibits the take of endangered species, and pursuant to §4 NMFS has extended that prohibition to threatened salmon and steelhead. Under the joint state-tribal 4(d) rule (50 CFR 223.203(b)(6)), those prohibitions are rescinded for hatchery activities described in an RMP, provided that:

- The Secretary of Commerce has determined pursuant to 50 CFR 223.204(b) [the Tribal 4(d) rule] and the government-to-government processes therein that implementing and enforcing the RMP will not appreciably reduce the likelihood of survival and recovery of listed salmon and trout;
- The joint plans applying for 4(d) limit 6 review will be implemented and enforced within the parameters set forth in *U.S. v. Oregon* or *U.S. v. Washington*; and
- The Secretary of Commerce has taken comment on how any HGMP addresses the 4(d) rule limit 5 criteria (§223.203(b)(5)).

The Muckleshoot Indian Tribe, Washington Department of Fish and Wildlife (WDFW), and the Suquamish Tribe, as co-managers of the fisheries resource under *United States v. Washington* (1974), have provided NMFS with ten hatchery and genetic management plans (HGMP) proposed for implementation in the Duwamish/Green River watershed and adjacent marine areas (Table 1; Fig. 1). The applicants have provided the HGMPs and supplementary information for review and determination by NMFS pursuant to limit 6 of the ESA 4(d) Rule. Each HGMP serves as an RMP for the purpose of limit 6 consideration; for this evaluation, descriptions of the proposed activities will focus on the descriptions given in the individual HGMPs.

The proposed plans are similar through: shared salmon population recovery and harvest augmentation objectives and effects; broodstock collection locations and actions; fish rearing and release sites; monitoring and evaluation actions; and funding sources (Muckleshoot Indian Tribe 2014; Muckleshoot Indian Tribe and Suquamish Indian Tribe 2017; Muckleshoot Indian Tribe et al. 2019; Schaffler 2019; Scott 2018; WDFW 2013; WDFW 2014a; WDFW 2014b; WDFW 2015; WDFW 2017). All ten HGMPs were assembled consistent with the Puget Sound Salmon Management Plan (1985), the Federal court orders under *U.S.* v. *Washington* (1974) that control fisheries harvest management and hatchery salmon production.

The programs have been designed to operate adaptively in response to infrastructure changes, habitat improvements or degradation, and natural-origin population responses in the Green River watershed. Program modifications are divided amongst four phases: 1) Current infrastructure, 2) Operation of the

Fish Restoration Facility, 3) Downstream fish passage provided at Howard Hanson Dam, 4) Evaluation of the potential for self-sustaining, natural-origin populations of one or more listed species above and below Howard Hanson Dam. The co-managers have included phases three and four to document the long-term intent of the programs, but recognize that information pertinent to the analysis of effects is likely to arise before transition to phases three and four occurs. Thus, the co-managers will contact NMFS prior to moving from phase two to phase three to enable an accurate analysis of the two latter phases on listed species in the Green River watershed.

**Table 1. Proposed salmon and steelhead hatchery programs for the Duwamish/Green River basin; ESA = Endangered Species Act.**

| Hatchery Program | ESA-listed? | Operator[2] | Program Purpose |
|---|---|---|---|
| Soos Creek Hatchery Fall Chinook Salmon | Yes | WDFW | Integrated/Segregated Harvest[3] |
| Fish Restoration Facility-Fall Chinook | Yes[1] | MIT | Segregated Harvest[3] |
| Fish Restoration Facility Green River Coho Salmon | No | MIT | Integrated Harvest |
| Keta Creek Complex Yearling Coho Salmon | No | MIT; SIT | Integrated Harvest |
| Soos Creek Hatchery Coho Salmon | No | WDFW | Integrated Harvest |
| Marine Technology Center Coho Salmon | No | WDFW | Segregated Harvest |
| Keta Creek Complex Fall Chum Salmon | No | MIT | Integrated Harvest |
| Fish Restoration Facility Winter Steelhead | Yes[1] | MIT | Integrated Conservation |
| Green River Native Winter (Late) Steelhead | Yes | WDFW | Integrated Conservation |
| Soos Creek Hatchery Summer Steelhead | No | WDFW | Segregated Harvest |

[1] These programs are not yet in operation, but will be added to the listing in anticipation of their operation.

[2] MIT = Muckleshoot Indian Tribe; WDFW = Washington Department of Fish and Wildlife; SIT = Suquamish Indian Tribe.

3 These programs are genetically linked: returns from an integrated component at Soos Creek Hatchery are then used as broodstock for a segregated component at Soos Creek Hatchery, and will be used as broodstock for a segregated program at the Fish Restoration facility when it becomes operational.

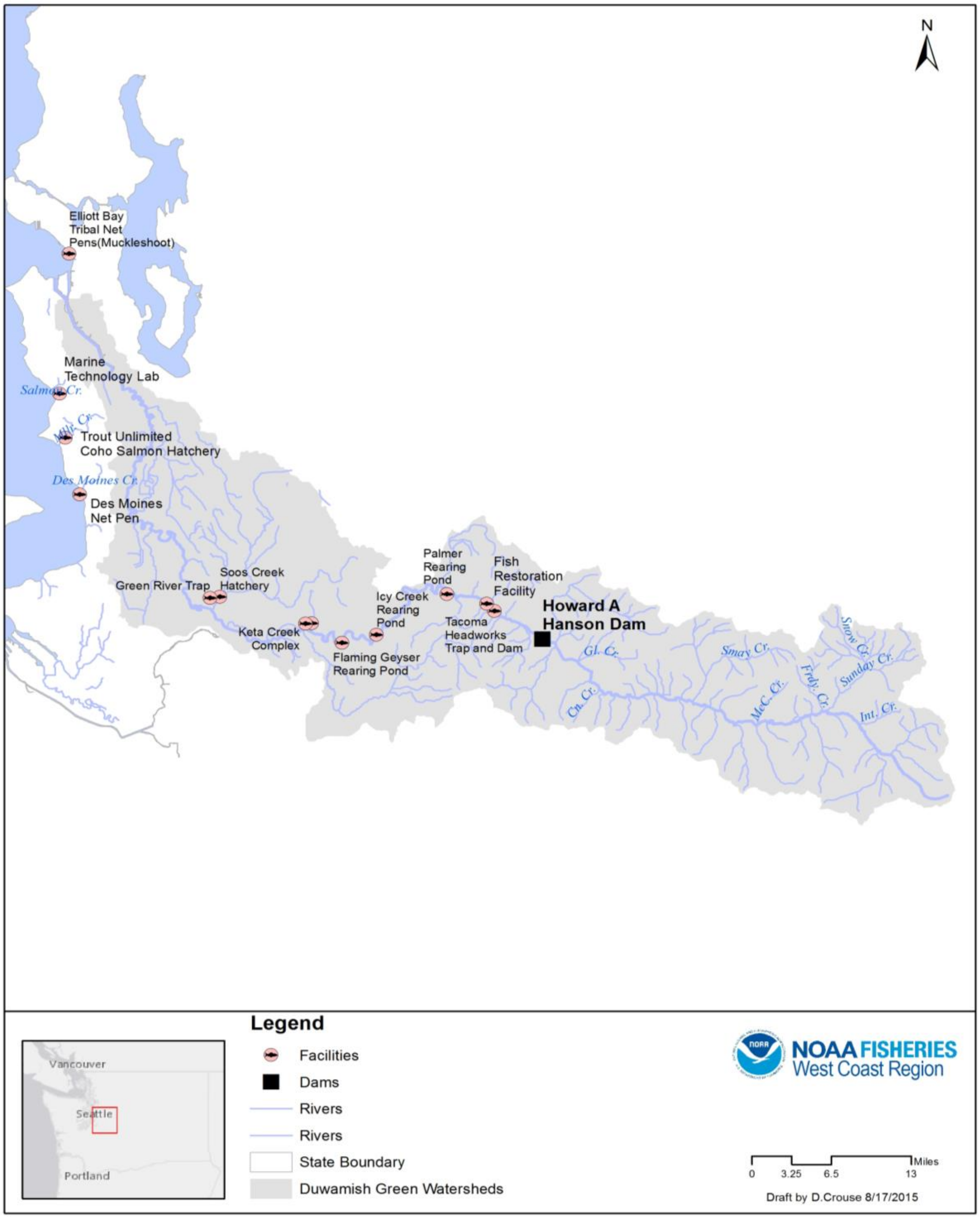


**Figure 1. Duwamish/Green River watershed, adjacent marine areas, and the facilities associated with the Duwamish/Green salmon and steelhead hatcheries.**

## 1.1 5(i)(A) The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in meeting those results.

Each of the HGMPs has clearly stated its goal, performance objectives, and methods for measuring the progress toward achieving those objectives. The general program goals described in Section 1.7 of each HGMP for propagating hatchery fish are to contribute to:

- Mitigating for lost natural-origin fish production
- Recovering ESA-listed Puget Sound Chinook salmon and steelhead
- Fulfilling federal tribal trust responsibility and treaty rights guaranteed through treaties and affirmed in *U.S. v. Washington* (1974)
- Providing for ceremonial and subsistence fishery values
- Meeting Pacific Salmon Treaty obligations

Performance objectives and performance indicators that would be used to gauge compliance with each objective, are described in Section 1.10 of each HGMP. Evaluation and monitoring to ensure standards and indicators are met are further described in Section 1.8 of this document and are summarized in Table 2.

Monitoring of HGMP implementation would generally be designed to determine:

1. Program consistency with proposed hatchery actions and intended results (e.g., juvenile fish release and adult return levels);
2. Measurement of the program's success or failure in attaining results; and
3. Effects of the program on listed natural-origin fish populations in Puget Sound freshwater and marine waters where these fish may migrate or return.

**Table 2. Summary of HGMP program performance standards and indicators.**

| Standard | Indicator |
|---|---|
| Produce fish for harvest while minimizing excess hatchery returns | • Measure adult harvest and escapement<br>• Mass marking to allow selective fisheries |
| Supplement natural population (integrated programs only) | • Increasing proportion of natural-origin fish<br>• Increasing natural smolt levels |
| Proper broodstock collection and management | • Collected randomly throughout the run<br>• Weir/trap checked regularly<br>• Proportion of natural-origin fish<br>• Designated mating scheme, sex ratio<br>• Adheres to spawning guidelines (Seidel 1983)<br>• Stray rates |
| Meet hatchery juvenile production goal | • Egg to fry or smolt survival is as expected<br>• Release target |
| Minimize interactions of releases with natural-origin fish | • Juveniles released at sea-water ready life stages<br>• Size and time of release accounts for listed stocks |
| Life history characteristics of the natural population do not change due to artificial propogation | • Stable life history patterns of natural fish<br>• Age and size data for natural population |
| Natural population genetic variation does not change due to artificial propagation | • Proportion of naturally spawning hatchery fish<br>• Genetic assessment |
| Limit pathogen amplification and transmission | • Follows co-manager fish health policy (WWTIT and WDFW 2006)<br>• Follows USFWS fish health policy (2004) |

## 1.2 5(i)(B) The HGMP utilizes the concepts of viable and critical salmonid population thresholds, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations."

HGMPs proposed for consideration under the 4(d) rule must use the concepts of viable and critical thresholds as defined in the NMFS Viable Salmonid Population (VSP) document (McElhany et al. 2000). Application of these VSP concepts is needed to adequately assess and limit the take of listed salmonids for the protection of the species. Section 2.2.2 of each HGMP describes the status of the listed Chinook salmon and steelhead populations relative to "critical" and "viable" population thresholds within the Green/Duwamish watershed and references NMFS reviews' of species status.

The current abundance and productivity of Green River natural-origin Chinook salmon are substantially reduced from historical levels that are estimated to have been approximately 37,700 adult fish with a return per spawner ratio of 3.2 at MSY (Ford et al. 2011; Watershed Resource Inventory Area 9 Steering Committee 2005). Between 1999 and 2014, the geometric mean total annual naturally spawning Chinook salmon escapement was 1,179 natural-origin spawners compared with the recovery goal of 27,000 fish at low productivity (NMFS 2006). This recovery goal would require a sizeable increase in both habitat capacity and productivity in the Green River basin. The escapement goal under this ‘properly functioning conditions’ scenario would be approximately 6,400 Chinook.

Hatchery-origin Chinook salmon associated with Soos Creek Chinook salmon hatchery program make up a sizable fraction of the annual naturally spawning adult abundance; averaging 63% for the basin (WDFW Score Database 2016)[1]. It is believed that the Green River watershed historically supported an early returning life history type of Chinook salmon but it is unclear if that was a distinct population or a diversity component of a larger population Based on the status of the fall Chinook population, the program is integrated to reduce the risks associated with genetic effects of hatchery fish spawning naturally.

Historical catch data included in Myers et al. (2015) estimated Green River steelhead run-sizes of 45,000 to 55,000 in the early 1900s. Recent abundance is less than two percent of historical abundances (2010-2014 geometric mean of 621; NWFSC 2015). Intrinsic potential (IP) production estimates[2] based on basin geological, hydrologic, and ecological characteristics indicate the Green River basin could historically have supported a total winter-run steelhead abundance of approximately 19,768 to 39,537 adults (Myers et al. 2015). The historical population structure is unknown for the Green River, but the Green River may have supported a native summer population (Puget Sound Steelhead Technical Recovery Team 2011). Based on the status of the steelhead population, the winter steelhead program is integrated with the primary immediate goal of aiding in population recovery. The summer steelhead hatchery program is designed to limit gene flow to the winter population.

### 1.3 5(i)(C) Taking into account health, abundances, and trends in the donor population, broodstock collection programs reflect appropriate priorities.

A prioritized purpose of a broodstock collection program using listed fish is to re-establish an indigenous salmonid population for conservation purposes, including restoration of similar at-risk populations within the same ESU, and reintroduction of at-risk populations to under-seeded habitat. Under this 4(d) rule criterion, as described in the 4(d) rule, listed salmonids may be intentionally taken for broodstock only if:

---

[1] https://fortress.wa.gov/dfw/score/score/maps/map_details.jsp?geocode=wria&geoarea=WRIA09_Duwamish_Green

[2] The intrinsic potential estimates include all habitat upstream of the estuary, including the mainstem and tributaries, as well as all habitat upstream of TPU diversion structure.

1. The donor population is currently at or above the viable threshold and the collection will not impair its function, or
2. The donor population is not currently viable but the sole objective is to enhance the propagation or survival of the listed ESU, or
3. The donor population is shown with a high degree of confidence to be above the critical threshold although not yet functioning at viable levels, and the collection will not appreciably slow attainment of viable status for that population.

Four programs take listed fish for broodstock: the Fish Restoration Facility (FRF) Fall Chinook Salmon, the Soos Creek Hatchery Fall Chinook Salmon, the FRF Winter Steelhead, and the Green River Native Winter Steelhead. The Soos Creek Hatchery Fall Chinook Salmon program is comprised of two genetically linked components; an integrated component of 1 million subyearlings, and a segregated component of 5.5 million (yearlings and subyearlings). For this type of program, adult returns from the integrated component are used as broodstock for the segregated component to minimize the risk of adverse genetic effects. Once the FRF Fall Chinook Salmon comes online in phase 2, this program will function as an expansion of the segregated component of the Soos Creek Fall Chinook Salmon program with an additional 600,000 subyearling fish produced. These programs rely on collection of Green River natural-origin adult fish for which the average annual return is above the critical threshold. This is consistent with number 3 above for the prioritized use of listed fish for broodstock. The co-managers also propose to limit natural-origin fish used for integrated broodstock to 40 percent of the projected post fishery return.

Broodstock used for non-listed programs are discussed in the following section (1.4).

A critical abundance threshold has not yet been established for the Green River winter-run steelhead population, but data indicate adult returns are below the viability threshold established for the population (Hard et al. 2015). To respond to the current low abundance of the population, the winter steelhead programs would rear fish initially for conservation purposes, transitioning in future years to harvest augmentation as the abundance of returning adults increases, which is consistent with number 2 above. Natural-origin winter-run steelhead would be incorporated as broodstock to limit divergence from the natural-origin component of the population while fish are under propagation. The program will limit the impact on native steelhead by taking no more than 20 percent of the annual natural run.

## 1.4 5(i)(D) The HGMP includes protocols to address fish health, broodstock collection and spawning, rearing and release of juveniles, disposition of hatchery adults, and catastrophic risk management.

The proposed HGMPs include protocols for fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management.

### Fish Health (HGMP Sections 7, 9, and 10)

All of the hatchery programs would be operated in compliance with the co-manager and USFWS fish health policies (USFWS 2004; WWTIT and WDFW 2006). The policies are designed to limit the spread of fish pathogens between and within watersheds by regulating the transfers of eggs and fish. The policies also outline standard fish health diagnosis, maintenance, and hatchery sanitation protocols to reduce the risk of pathogen amplification and transmission within the hatchery and to fish in the natural

environment during broodstock collection and mating as well as fish incubation, rearing, and release. Fish health specialists and pathologists from WDFW, NWIFC, or the USFWS would provide fish health management support and diagnostic fish health services.

**Broodstock Collection and Spawning (HGMP Sections 6, 7, and 8)**

Both natural and hatchery-origin fish are used for 8 of the 10 programs, consistent with the purpose of the integrated programs. As mentioned above the FRF fall Chinook salmon program does not use natural-origin fall Chinook salmon, but is genetically linked to the integrated component of the Soos Creek fall Chinook salmon program through the use of integrated adult returns for broodstock. The Soos Creek Hatchery Summer Steelhead uses only hatchery adult returns to Soos Creek Hatchery as broodstock. Due to the non-native ancestry of this summer steelhead stock (Skamania), the co-managers are actively considering options to transition to a local stock, but none exists in the Green River.

The protocols for broodstock implement spawning actions consistent with published guidelines (HSRG 2004; Seidel 1983). Pairwise spawning is logistically easier, especially for larger programs, but factorial spawning (e.g., eggs from a single female are fertilized by multiple males and a single male fertilizes multiple females) conserves genetic diversity by limiting the risk of use of a sterile adult during spawning (Busack and Knudsen 2007). For 9 of the 10 programs, pairwise spawning with a back-up male is used to ensure fertilization. The Green River native winter steelhead program uses factorial spawning. Broodstock collection and spawning details are summarized in Table 3.

**Table 3. Annual number of broodstock collected, collection method, and spawning approach.**

| Program | Local source | Collection Location(s) | Collection Method | Collection/ Holding Target | Collection Duration | pNOB |
|---|---|---|---|---|---|---|
| Soos Creek Fall[1] Chinook: integrated component | Hatchery and natural | SCH, IC, PP, TPU, FRF, Green River | Ladder, weir and trap, seine, net | 700[2] | August-October | up to 1 |
| Soos Creek Fall[1] Chinook: segregated component | Hatchery | | | 4,100 | August-October | 0 |
| FRF Fall Chinook[1] | | | | | | |
| FRF Coho | Hatchery and natural | TPU, FRF | Ladder, weir and trap | 4,580 | October-December | up to 1 |
| KCC Yearling Coho | | KCC, SCH, TPU, MTC, MCH | | | | up to 1 |
| Soos Creek Coho | | | | | | up to 1 |
| MTC Coho | | | | | | up to 1 |
| KCC Fall Chum | Hatchery and natural | KCC | Ladder and trap | 5,000 | October-December | up to 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| FRF Steelhead[2] | Hatchery and natural | TPU, FRF, SCH, IC, PP Green River | Ladder, weir and trap; Angling, seine, net | 110 | December-April | up to 1 |
| Green River Native Winter Steelhead[2] | Hatchery and natural | | | 50 | December-April | up to 1 |
| Green River Summer Steelhead[3] | Hatchery: Skamania stock | IC, SCH | Weir and trap | 100 | July-January | 0 |

[1] Excess natural-origin fall Chinook salmon collected for broodstock will be released back into the mainstem Green River. The fall Chinook salmon programs will use no more than 40% of the natural-origin return for broodstock. Only natural-origin fall Chinook salmon are passed above the Soos Creek weir.
[2] Excess natural-origin steelhead broodstock will be released back into the mainstem Green River. The winter steelhead programs will use no more than 20% of the natural-origin return for broodstock, and target a minimum pNOB of 50%.
[3] The co-managers are discussing development of a plan to transition to a more local summer steelhead stock.

**Rearing and Release of Juveniles (HGMP Sections 9 and 10)**

Fish from a majority of the programs would be released as seawater-ready smolts (or, for chum salmon, fed fry) to ensure rapid emigration downstream through watershed areas where interactions with rearing listed fish may occur. The exceptions are the Soos Creek Hatchery coho salmon cooperative program, and the Keta Creek Complex yearling coho program, which places some coho in marine net pens for acclimation.. Release numbers, life stage, location, percentage marked, and dates for all hatchery programs are detailed in Table 4. Survival rates from the green-egg life stage to release for the programs rearing listed Chinook salmon and steelhead for which data are available are reflective of well-operated hatchery programs.

**Table 4. Fish release details in the Duwamish/Green watershed; SCH = Soos Creek Hatchery, IC = Icy Creek Rearing Ponds, FGP = Flaming Geyser Ponds, KCC = Keta Creek Complex, MCH = Miller Creek Hatchery, MTC = Marine Technology Center; FRF = Fish Restoration Facility, TBD = to be decided.**

| Program | Number[2], life stage, and size (fpp) | Percentage marked | Egg incubation and rearing location | Release location | Volitional release? | Release time |
|---|---|---|---|---|---|---|
| Soos Creek Fall Chinook | 3,200,000 subyearling; 80 | 100 | SCH | SCH[3] | No | Early May-June |
| | 1,000,000 subyearling; 80 | 100 | SCH | SCH | No | |
| | 2,000,000 subyearling; 45 | 100 | SCH, FRF[3] | Palmer Ponds, SCH, FRF, IC[4] | Yes | June-July 4 |
| | 300,000 yearling; 10 | 100 | SCH | IC | Yes | April |
| FRF Fall Chinook[1] | 600,000 subyearling; 65 | 100 | FRF | FRF, Palmer Ponds | TBD | June |
| FRF Coho[1] | 600,000 yearling; 14 | 100 | FRF | FRF | TBD | April 1-May 15 |
| KCC Coho | 1,000,000 yearling; 14 | 100 | KCC | KCC | Yes | April 1-May 10 |
| | 1,000,000 yearling; 9 | 100 | KCC | Elliott Bay netpens | No | April 1-May 15 |
| | 50,000 yearling; 14 | None | KCC | FRF site | Yes | April 1-May 10 |
| Soos Creek Coho | 600,000 yearling; 17 | 100 | SCH | SCH | Yes | Mid-April-June 30 |
| | 30,000 yearling; 15 | 100 | SCH | Des Moines Ponds | No | June |
| | 120,000 fed fry; 1500 | None | MCH | Miller, Walker and Des Moines Creeks | No | January |
| KCC Fall Chum | 5,000,000 fry; 450-150 | None | KCC | KCC | No | March 1-May 15 |
| MTC Coho | 10,000 yearling; 11 | 100 | MTC | MTC | No | April |
| FRF steelhead[1] | 250,000 yearling; 5-10 | 100 | FRF | FRF | TBD | Mid-April-June 30 |
| Green River Native Winter Steelhead | 23,000 yearling; 8 | 100 | SCH | IC | Yes | May |
| | 15,000 yearling; 8 | 100 | SCH | FGP | Yes | |
| | 17,000 yearling; 8 | 100 | SCH | Palmer Ponds | Yes | |
| Green River Summer Steelhead | 50,000 yearling; 5 | 100 | SCH | SCH and/or IC | Yes[5] | Mid-April - May |
| | 50,000 yearling; 5 | 100 | SCH | | Yes[5] | |

[1] These programs will not be operational until phase 2.
[2] In years of high within-hatchery survival, juvenile levels higher than the proposed release numbers may occur. The co-managers plan to limit production to no more than 110% of levels described in the HGMPs and in Table 4; an overage of 10% is anticipated to be a rare occurrence.
[3] Up to 1 million subyearlings may undergo final rearing and release at Palmer Ponds as needed as agreed to by the co-managers annually.
[4] Palmer Ponds is the targeted release site for these fish, but other sites listed here may be used as needed or available as agreed to by the co-managers annually. Under phase 2, when the FRF becomes operational, a portion of this release may be reared and released at the FRF.
[5] Smolts that do not migrate from rearing ponds after a four-week period are collected and planted into non-anadromous waters

### Disposition of Hatchery Adults (HGMP Sections 7.5 and 7.8)

Adult fish collected in excess of annual broodstock needs are released to spawn naturally, sold to a contracted fish buyer, or distributed to the treaty tribes for subsistence use. For the listed programs, excess hatchery-origin fish are released to spawn naturally until their escapement goals are met (4,423 for Chinook salmon, and 2,020 for steelhead), then removal could occur at any of the adult collection facilities in the Basin that is necessary to meet adult management goals. The Marine Technology Lab Program kills and freezes any excess coho salmon broodstock for use in class dissections as part of the school curriculum. Spawned carcasses may also be sold to a contracted fish buyer, or distributed to the treaty tribes for subsistence in addition to being placed throughout the watershed for marine-derived nutrient enhancement purposes. Native winter-run steelhead that are live-spawned are released to potentially spawn again (males) and return to the ocean for an additional cycle.

### Catastrophic Risk Management (HGMP Section 5.8)

All facilities identified in Table 5 adhere to the applicants' fish health policies (USFWS 2004; WWTIT and WDFW 2006).

**Table 5. Additional measures taken to reduce the likelihood of catastrophic fish loss at the hatchery facilities. NA = not applicable; net pen programs are within Puget Sound and have a ready supply of water.**

| Facility | Personnel | Water | Power loss |
|---|---|---|---|
| Fish Restoration Facility | On-station personnel | Alarm | Back-up generator |
| Soos Creek Hatchery | On station at all times | Low water alarm | Back-up generator |
| Keta Creek Complex | On station at all times | Low water alarm | Back-up generator |
| Marine Technology Lab | | Low water alarm | Back-up generator |
| Trout Unlimited Miller Creek Coho Salmon Hatchery | | | Back-up generator |
| Icy Creek Rearing Ponds | Checked daily | Low water alarm | Gravity-fed water supply |
| Flaming Geyser Rearing Ponds | | | Gravity-fed water supply |
| Palmer Rearing Ponds | | | Gravity-fed water supply |
| Elliott Bay Net Pens | Checked daily | NA | NA |
| Des Moines Net Pen | Checked daily | NA | NA |

## 1.5 5(i)(E) The HGMP evaluates, minimizes, and accounts for the propagation programs' genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by straying of hatchery fish.

The Duwamish/Green River basin HGMPs provide evaluations of potential genetic and ecological effects on listed salmon and steelhead in Section 2 and risk minimization measures in Sections 6-10.

### Genetic effects

Artificial fish production may result in a loss of within-population genetic diversity (the reduction in quantity, variety and combinations of alleles in a population), outbreeding depression (loss in fitness caused by changes in allele frequency or the introduction of new alleles) and/or hatchery-influenced selection (Busack and Currens 1995). Genetic effects of fall chum and coho salmon on ESA-listed Chinook salmon and steelhead in the Duwamish/Green River basin are unlikely because these species do not interbreed. Therefore, our consideration of their discussion of genetic effects focuses on the propagation of Chinook salmon and steelhead.

Because the two Chinook salmon and two winter-run steelhead programs are operated as integrated programs, some interbreeding between hatchery- and natural-origin fish is an objective. The HGMPs account for and minimize genetic risks through implementation of the following measures:

- Broodstock are randomly collected throughout the adult return to ensure full representation of run timing, age class, and sex ratio
- Factorial mating of steelhead ensures that all fish contribute to the production of progeny to retain genetic diversity
- Natural-origin fish are incorporated into the broodstock to limit divergence from the Duwamish/Green native populations
- Only natural-origin fall Chinook salmon are passed above the Soos Creek weir
- All fish are marked to differentiate them from other Chinook salmon and steelhead stocks, assess out-of-basin straying, and measure proportions of hatchery- and natural-origin spawners
- Juveniles are acclimated at their site of release to decrease straying potential. Acclimation of hatchery juveniles before release increases the probability that hatchery adults will home back to the release location, reducing their potential to stray into natural spawning areas (Dittman and Quinn 2008)

### Ecological effects

The primary ecological risks to natural-origin salmon and steelhead populations posed by salmon and steelhead hatchery programs are identified in the HGMPs as competition for food resources

and space, and predation (NMFS 2012). Pathogen transfer and amplification are also risk factors. As noted in the HGMPs and earlier in this document, all hatchery actions would be implemented in accordance with the co-manager and USFWS fish health policies (USFWS 2004; WWTIT and WDFW 2006) to account for and minimize the risks of pathogen transmission and amplification.

All of the HGMPs have incorporated some of the following measures to minimize competition and predation risks associated with program implementation:

- Fish are released as seawater-ready smolts or fry to foster rapid emigration seaward, maximizing clearance from freshwater and estuarine areas where natural fish would be most concentrated and most vulnerable to ecological interactions.
- Releases of juvenile fish will be made during freshets and elevated turbidity, when possible, to speed outmigration
- Fall chum salmon fed fry are too small at the time of their release to prey on or compete with any co-occurring natural-origin juvenile Chinook salmon and steelhead
- Yearling coho produced by the two net pen facilities are released directly into saltwater, with no freshwater interactions with natural-origin fish
- Releases typically occur from mid-April to May after the majority of natural-origin juveniles have emigrated, and prior to the emergence of steelhead fry

## 1.6 5(i)(F) The HGMP describes interrelationships and interdependencies with fisheries management.

The HGMPs describe the relationship of the proposed actions with fisheries management in Section 3.

The HGMPs indicate that all co-managed hatchery programs in the Puget Sound region would operate consistent with the *U.S. v. Washington* (1974) fisheries management framework. This legal framework sets forth required measures for coordinating implementation of State and tribal hatchery programs, defining artificial production objectives, and maintaining treaty-fishing rights through the court-ordered Puget Sound Salmon Management Plan (PSSMP 1985). This fisheries resource co-management process requires that both the State of Washington and the Puget Sound Tribes develop salmon and steelhead hatchery program goals and objectives, and reach agreement on the function, purpose, and fish production strategies for all Puget Sound hatchery programs.

The goals of the HGMPs include providing hatchery-origin Chinook, coho, and fall chum salmon and steelhead for harvest to support fisheries. State recreational and tribal fisheries for hatchery-origin species may incidentally affect natural-origin Chinook salmon and steelhead. However, these fisheries are not considered interrelated with or interdependent on these programs because these programs are not the sole producers of fish for the fisheries.

## 1.7 5(i)(G) Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, to maintain population health and diversity, and to avoid hatchery-influenced selection and domestication.

The two programs that propagate ESA-listed Chinook salmon and winter-run steelhead utilize multiple facilities. This approach reduces the risk of maintaining listed fish at a single location while under propagation, lessening the potential for catastrophic loss of rearing populations in the event of water or power failure at one facility. As described in Sections 4 and 5 of the HGMPs, the hatchery facilities used to implement the programs have adequate surface and groundwater sources, egg incubation and fish rearing vessels, and fish release facilities to ensure proper rearing of listed Chinook salmon and steelhead while under propagation. In 2012-2019, a number of improvements were made to Soos Creek Hatchery to further ensure safety of listed Chinook salmon and winter-run steelhead including construction of a new incubation building and incubation settling pond; six new rearing ponds; a new water distribution tower and water supply line; and a new two-bay pollution abatement pond.

Facilities that rear over 20,000 pounds of fish operate under applicable National Pollutant Discharge Elimination System (NPDES) general permits, which provide for monitoring of temperature, chlorine, and settleable and suspended solids in facility effluent. As mentioned previously, fish health is maintained throughout rearing by adhering to fish health policies and using pathogen-free water sources when possible (USFWS 2004; WWTIT and WDFW 2006). Minimization of catastrophic loss and genetic risks associated with these programs were addressed in Sections 1.4 and 1.5, respectively, of this document.

## 1.8 5(i)(H) Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of the listed ESU.

The HGMPs include implementation of adequate monitoring and evaluation actions to evaluate the performance of each program in meeting program objectives. These actions are summarized in Section 1.10, and are further described in Section 11 of each HGMP. Some of these activities may be covered using other ESA pathways (e.g., Section 10 research permits), but the information obtained may be relevant to our evaluation of the hatchery program. Monitoring and evaluation actions implemented include:

- Spawning ground/redd surveys to determine percent of naturally spawning hatchery-origin fish
- Trapping of outmigrating juveniles to determine post-release emigration timing, emigration rate, and hatchery fish predation levels on natural fish
- Calculating estimates of smolt-to-adult survival rates, harvest of hatchery fish, and straying of Duwamish/Green hatchery salmon to other Puget Sound watersheds using mark recovery programs and creel surveys

- Collection of abundance, timing, age class, sex ratio, and fish health condition data for broodstock to assess run traits of the target populations
- Monitoring of water withdrawal and effluent to ensure compliance with permitted levels
- Monitoring of broodstock collection, egg take, fish survival rates in hatchery, smolt or fry release levels, and hatchery and natural fish escapement to the hatcheries to ensure compliance with program goals
- Fish health monitoring and reporting in compliance with fish health policies.

### 1.9 5(i)(I) The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed.

Under the HGMPs in Section 1.10, data collected relating to hatchery program performance and effects would be evaluated by the applicants to determine whether performance standards were are being met. Annual reports for the programs assembled by the applicants would be jointly reviewed by NMFS to document program results, and to determine if adjustments to the programs' assumptions and management strategies are warranted. Any changes would be incorporated into Future Brood Documents, Annual Operating Plan documents, and/or the HGMPs as necessary. These programs are enforced through the *U.S. v. Washington* Management Agreement process, upon review of annual reports and operating plans. The tribes and WDFW employ enforcement officers throughout the area, who are responsible for on the ground enforcement to prevent ESA violations.

### 1.10 5(i)(J) NMFS provides written concurrence [with] the HGMP, which specifies the implementation and reporting requirements.

After completion of the public review and comment period for this proposed evaluation and pending determination document, and after consulting with itself under section 7 of the ESA, NMFS will make a determination regarding the adequacy of the ten Duwamish/Green River basin HGMPs. If the determination is made that implementing and enforcing the plans will not appreciably reduce the likelihood of survival and recovery of the ESA-listed species, and that the plans address all the criteria specified in limit 6 of the 4(d) rule, NMFS will so notify the applicants in writing, and will specify any necessary implementation and reporting requirements.

### 1.11 5(i)(K) The HGMP is consistent with plans and conditions set within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

The Duwamish/Green River basin salmon and steelhead HGMPs were developed by the applicants pursuant to the *U.S. v. Washington* (1974) fisheries and hatchery management framework. The HGMPs are one component of an effort to preserve and recover to a fishable status listed Chinook salmon, steelhead, and other non-listed salmon and steelhead populations in the Duwamish/Green River watershed. The ESU recovery plan for Chinook salmon (NMFS 2006;

SSPS 2007) has hatchery, harvest, and habitat components, and includes monitoring, research, and restoration recommendations to complement artificial production. The hatchery actions described in the HGMPs are included within, and consistent with, this recovery plan. There are no other plans or conditions set within Federal court proceedings, including memorandums of understanding, court orders, or other management plans, that direct operation of the proposed salmon and steelhead hatchery programs.

## 2 RECOMMENDED DETERMINATION

As required by limit 6 of the 4(d) rule, the Secretary sought comment from the public on the pending determination as to whether or not the plans evaluated here would appreciably reduce the likelihood of survival and recovery of the listed salmon and steelhead. In addition, comment was sought on whether the plans met the requirements of limit 6 of the 4(d) rule. Our responses to public comments are included below in Section 4.

NMFS has reviewed the plans and evaluated them together against the requirements of the 4(d) Rule. Based on this review and evaluation, NMFS' pending determination, subject to information provided during public comment, is that activities implemented as described would not appreciably reduce the likelihood of survival and recovery of ESA-listed species. This pending determination does not prejudge the outcome of any additional environmental reviews that may be scheduled to be completed prior to a final determination. As required in (6)(iv) of section 223.203 of the 4(d) rule for salmon and steelhead, the Secretary will publish notice of his determination together with a discussion of the biological analysis underlying that determination.

## 3 REEVALUATION CRITERIA

NMFS will reevaluate this determination if: (1) the actions described by the plans are modified in a way that causes an effect on the listed species that was not previously considered in NMFS' evaluation; (2) new information or monitoring reveals effects that may affect listed species in a way not previously considered; or (3) a new species is listed or critical habitat is designated that may affect NMFS' evaluation of the plans.

## 4 PUBLIC COMMENTS AND RESPONSES

During the public comment period, NMFS received comments from four entities relevant to the action. One entity stated their support for hatchery programs, while another did not support hatchery production. Detailed responses for the remaining comments follow below. Comment #2 and #3 came in during the PEPD comment period, but they largely pertain to NMFS' biological opinion for which we did not seek comments. However, we will address those comments here as we recognize the complexity of the issue and believe responses are warranted.

*Comment #1:*

All carcasses should be used for nutrient enhancement, and not sold to a fish buyer.

*Response:*

The co-managers use some carcasses for nutrient enhancement, but currently there is not biological analysis that defines the optimum number of carcasses needed for nutrient enhancement in the Green River Basin.

*Comment #2:*

The commenters state that the PEPD assumes the winter steelhead hatchery programs will have positive benefits for productivity of wild steelhead because they primarily use wild salmonids for broodstock, which the commenters believe substantially discounts the weight of evidence on the fitness of hatchery salmonids in those types of programs and entirely misses the genetic effects that arise due to hatchery rearing.

*Response:*

Section 2.5.2.2 of the biological opinion states, “this supplementation is designed to increase population abundance and productivity by increasing the number of adult returns.” We should not have included the word “productivity” in this sentence. We have amended our record to correct this. However, this edit did not affect our overall conclusions.

We do not believe the PEPD or biological opinion discounts the weight of evidence that suggests hatchery-origin fish can adversely affect the fitness of natural-origin fish. We describe these potential effects in much detail. Although some relative reproductive success (RRS) studies since 2014 have found little difference in RRS between wild and hatchery fish, we describe how incorrect inferences about the strength (or lack of strength) of genetic effects can easily be made from studies not designed to detect them (e.g., studies with low statistical power).

Because of our mandate to use the best available science, we review research papers very critically. This is especially true of papers that attract a lot of public interest, such as Christie et al. (2016), which purported to show differential levels of gene expression between hatchery and wild fish at 723 genes. We have a number of concerns about the methodology and results reported in this paper. The commenters link this work with ongoing research into epigenetics. Epigenetics may be an important factor in domestication, but the research is at present far from conclusive. Both Le Luyer et al. (2017) and Gavery et al. (2018) demonstrated methylation differences between hatchery and wild fish, but Gavery’s most recent work (Gavery et al. 2019) showed that much of early-life methylation disappeared later.

*Comment #3:*

The commenter states that the PEPD bases its assumption that the winter steelhead hatchery programs will have positive benefits for abundance of wild steelhead primarily on broodstock origin and misses many potential issues which could result in a deleterious effect. Further, the commenter claims the model used to provide the analysis of effective population size in the biological opinion is outdated and not supported by more recent empirical evidence on steelhead.

*Response*:

The commenter's claim that we used an outdated model seems to be based largely on the results of Christie et al. (2012). Perhaps we should have detailed more fully the assumptions behind our modeling, but our results are not outdated, and not inconsistent with Christie et al. (2012). Those authors documented a strong recurring Ryman-Laikre effect (Ryman and Laikre 1991) for several consecutive brood years. This is not surprising, given the small broodstock size, and the large contribution of hatchery fish to natural spawning. In an ongoing program, however, it is the multi-generation effective size that is important, and the Ryman-Laikre equation is just a snapshot that does not predict the multi-generation effective size, an issue pointed out in several papers (e.g., Duchesne and Bernatchez 2002; Lynch and O'Hely 2001; Waples et al. 2016). For calculation of multi-generation effective size in our biological opinion, we used the methods of Tufto and Hindar (2003). Applying these methods to the Christie et al.'s data shows that although the Ryman-Laikre effect is quite large, the multi-generation impact depends greatly on broodstock composition: the Nc:Nb ratio could be as high as 0.85, but could be as low as 0.15.

## 5 References

Busack, C., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. AFS Symposium 15:71-80.

Busack, C., and C. M. Knudsen. 2007. Using factorial mating designs to increase the effective number of breeders in fish hatcheries. Aquaculture 273:24-32.

Christie, M. R., M. J. Ford, and M. S. Blouin. 2014. On the reproductive successs of early-generation hatchery fish in the wild. Evolutionary Applications 7:883-896.

Christie, M. R., M. L. Marine, S. E. Fox, R. A. French, and M. S. Blouin. 2016. A single generation of domestication heritably alters the expression of hundreds of genes. Nature Communications 7:10676.

Christie, M. R., M. L. Marine, R. A. French, R. S. Waples, and M. S. Blouin. 2012. Effective size of a wild salmonid population is greatly reduced by hatchery supplementation. Heredity 109:254-260.

Dittman, A. H., and T. P. Quinn. 2008. Assessment of the Effects of the Yakima Basin Storage Study on Columbia River Fish Proximate to the Proposed Intake Locations. A component of Yakima River Basin Water Storage Feasibility Study, Washington. Technical Series No. TS-YSS-13. U.S. Department of the Interior, Denver, Colorado. 179p.

Duchesne, P., and L. Bernatchez. 2002. An analytical investigation of the dynamics of inbreeding in multi-generation supportive breeding. Conservation Genetics 3:47-60.

Ford, M. J., and coauthors. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. November 2011. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-113. 307p.

Gavery, M. R., and coauthors. 2019. Temporal dynamics of DNA methylation patterns in response to rearing juvenile steelhead (*Oncorhynchus mykiss*) in a hatchery versus simulated stream environment. Genes 10(5):356.

Gavery, M. R., K. M. Nichols, G. W. Goetz, M. A. Middleton, and P. Swanson. 2018. Characterization of genetic and epigenetic variation in sperm and red blood cells from adult hatchery and natural-origin steelhead, *Oncorhynchus mykiss*. G3: Genes, Genomes, Genetics 8(11):3723-3736.

Hard, J. J., and coauthors. 2015. Viability Criteria for Steelhead within the Puget Sound Distinct Population Segment. May 2015. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-129. 367p.

Hess, M. A., and coauthors. 2012. Supportive breeding boosts natural population abundance with minimal negative impacts on fitness of a wild population of Chinook salmon. Molecular Ecology 21:5236-5250.

HSRG. 2004. Hatchery reform: Principles and Recommendations of the Hatchery Scientific Review Group. April 2004. Available at Long Live the Kings. 329p.

Le Luyer, J., and coauthors. 2017. Parallel epigenetic modifications induced by hatchery rearing in a Pacific salmon. PNAS 114(49):12964–12969.

Lynch, M., and M. O'Hely. 2001. Captive breeding and the genetic fitness of natural populations. Conservation Genetics 2:363-378.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42. 174p.

Muckleshoot Indian Tribe. 2014. Keta Creek Complex Hatchery Program, Fall Chum Salmon, Green-Duwamish, Puget Sound HGMP. July 18, 2014. 41p.

Muckleshoot Indian Tribe, and Suquamish Indian Tribe. 2017. Keta Creek Complex Hatchery Program, Green River Coho - Yearlings, Green River (Puget Sound) HGMP. June 22, 2017. 53p.

Muckleshoot Indian Tribe, WDFW, and Suquamish Indian Tribe. 2019. Green Chinook Broodstock Management_February 27, 2019_WDFW excel report.

Myers, J. M., and coauthors. 2015. Identifying Historical Populations of Steelhead within the Puget Sound Distinct Population Segment. March 2015. U.S. Dept. Commer., NOAA Technical Memorandum NMFS NWFSC-128. 175p.

NMFS. 2006. Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. November 17, 2006. NMFS, Portland, Oregon. 47p.

NMFS. 2012. Effects of Hatchery Programs on Salmon and Steelhead Populations: Reference Document for NMFS ESA Hatchery Consultations. December 3, 2012. Northwest Region, Salmon Managment Division, Portland, Oregon. 50p.

NWFSC. 2015. Status Review Update for Pacific Salmon and Steelhead listed under the

Endangered Species Act: Pacific Northwest. December 21, 2015. NWFSC, Seattle, Washington. 356p.
Puget Sound Salmon Management Plan. 1985. *United States of America vs. State of Washington* No. 9213 Phase I (sub no. 85-2). October 17, 1985. Order Adopting Puget Sound Salmon Management Plan. 50p.
Puget Sound Steelhead Technical Recovery Team. 2011. Identifying Historical Populations of Steelhead within the Puget Sound Distinct Population Segment. 31 October 2011 Review Draft. NMFS NWFSC, Seattle, Washington. 110p.
Ryman, N., and L. Laikre. 1991. Effects of supportive breeding on the genetically effective population size. Conservation Biology 5(3):325-329.
Schaffler, J. 2019. MIT Fish Restoration Facility Steelhead program proposal_March 1, 2019_MIT.
Scott, J. 2018. Email to Charlene Hurst (NMFS) from James Scott (DFW). Green_Duwamish Meeting Agenda for June 14, 2018. Clarification on release number for Soos Creek fall Chinook salmon program. June 21, 2018. 2p.
Seidel, P. 1983. Spawning Guidelines for Washington Department of Fisheries Hatcheries. 18p.
SSPS. 2007. Puget Sound Salmon Recovery Plan. Volumes I, II and III. Plan Adopted by the National Marine Fisheries Service (NMFS) January 19, 2007. Submitted by the Shared Strategy Development Committee. Shared Strategy for Puget Sound. Seattle, Washington. 503p.
Tufto, J., and K. Hindar. 2003. Effective size in management and conservation of subdivided populations. Journal of Theoretical Biology 222:273-281.
USFWS. 2004. U.S. Fish & Wildlife Service handbook of aquatic animal health procedures and protocols.
Wang, J., and N. Ryman. 2001. Genetic effects of multiple generations of supportive breeding. Conservation Biology 15(6):1615-1631.
Waples, R. S., K. Hindar, S. Karlsson, and J. J. Hard. 2016. Evaluating the Ryman-Laikre effect for marine stock enhancement and aquaculture. Current Zoology 62(6):617–627.
*Washington, U. S. v.* 1974. 384 F. Supp 312 (W.D. Wash.), aff'd, 500F.2nd 676 (9thCr. 1975, cert. denied), 423 U.S. 1086 (1976). Seattle, Washington.
Watershed Resource Inventory Area 9 Steering Committee. 2005. Salmon Habitat Plan: Making Our Watershed Fit for a King. Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area 9. August 2005. Prepared for the WRIA 9 Forum. 246p.
WDFW. 2013. Soos Creek Fall Chinook Hatchery Program (Integrated) Hatchery Program, Green River Fall Chinook (*Oncorhynchus tshawytscha*), Green River (Duwamish) / Puget Sound Draft HGMP. April 3, 2013. 53p.
WDFW. 2014a. Marine Technology Center Coho Hatchery Program (Segregated), Coho (*Oncorhynchus kisutch*) Green River Stock (originally), Central Puget Sound Draft HGMP. September 17, 2014. 46p.
WDFW. 2014b. Soos Creek Coho Hatchery Program (Integrated) Hatchery Program, Coho (*Oncorhynchus kisutch*) Green River stock, Duwamish/Green River Puget Sound HGMP.

July 24, 2014. 55p.
WDFW. 2015. Soos Creek (Green River) Hatchery Summer Steelhead Program (Segregated), Duwamish/Green River, Puget Sound HGMP. October 23, 2015. WDFW, Auburn, Washington. 57p.
WDFW. 2017. Green River Native Winter (late) Steelhead Hatchery Program (Integrated), Winter (late) Steelhead (*Oncorhynchus mykiss*) Green River Stock, Green River (Duwamish)/ Puget Sound HGMP. October 18, 2017. 56p.
Willi, Y., J. V. Buskirk, and A. A. Hoffmann. 2006. Limits to the adaptive potential of small populations. Annual Review of Ecology, Evolution, and Systematics 37:433-458.
Willoughby, J. R., and M. R. Christie. 2017. Captive ancestry upwardly biases estimates of relative reproductive success. Journal of Heredity 108(5):583–587.
WWTIT, and WDFW. 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Revised July 2006. 38p.

# Exhibit 11

**Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation**

Ten Hatchery Programs for Salmon and Steelhead in the Duwamish/Green River Basin

NMFS Consultation Number: WCR-2016-00014

Action Agencies: National Marine Fisheries Service
Bureau of Indian Affairs

Affected Species and Determinations:

| ESA-Listed Species | Status | Is the Action Likely to Adversely Affect Species or Critical Habitat? | Is the Action Likely To Jeopardize the Species? | Is the Action Likely To Destroy or Adversely Modify Critical Habitat? |
|---|---|---|---|---|
| Puget Sound steelhead (*Oncorhynchus mykiss*) | Threatened | Yes | No | No |
| Puget Sound Chinook salmon (*O. tshawytscha*) | Threatened | Yes | No | No |
| Hood Canal Summer Chum (*O. keta)* | Threatened | No | No | No |
| Ozette Lake Sockeye Salmon (*O. nerka*) | Threatened | No | No | No |

| Fishery Management Plan That Describes EFH in the Project Area | Does the Action Have an Adverse Effect on EFH? | Are EFH Conservation Recommendations Provided? |
|---|---|---|
| Pacific Coast Salmon | Yes | Yes |
| Pacific Coastal Pelagic Species | No | No |
| Pacific Coast Groundfish | No | No |

Consultation Conducted By: National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division

Issued By:

Ryan J. Wulff
Assistant Regional Administrator
Sustainable Fisheries Division

Date: April 15, 2019

This page intentionally left blank.

**TABLE OF CONTENTS**

## FIGURES



## TABLES

# 1. INTRODUCTION

This introduction section provides information relevant to the other sections of the document and is incorporated by reference into Sections 2 and 3 below. The underlying activities that drive the Proposed Actions are the operation and maintenance of 10 hatchery programs rearing and releasing salmon and steelhead in the Duwamish/Green River Basin (Green River Basin). The hatchery programs are operated by state and/or tribal agencies as described in Table 1. Each program is described in detail in a Hatchery and Genetic Management Plan (HGMP), which were submitted to the National Marine Fisheries Service (NMFS) for review.

**Table 1. Green River watershed HGMPs submitted to NMFS for evaluation of ESA-listed salmon and steelhead effects.**

| Hatchery and Genetics Management Plan | Program Operator[1] | Program Funder[1] |
|---|---|---|
| Soos Creek Fall Chinook Hatchery Program | WDFW | WDFW, MIT, PSRE, DJ |
| Fish Restoration Facility-Fall Chinook Salmon | MIT | MIT, BIA |
| Fish Restoration Facility Green River Coho Salmon | MIT | MIT, BIA |
| Keta Creek Complex Yearling Coho Hatchery Program | MIT, SIT | MIT, SIT, BIA |
| Soos Creek Coho Hatchery Program | WDFW | PSRE, DJ, WDFW |
| Keta Creek Complex Fall Chum Hatchery Program | MIT | MIT, BIA |
| Marine Technology Center Coho Hatchery Program | WDFW | PSSC |
| Fish Restoration Facility Winter Steelhead | MIT | MIT, BIA |
| Green River Native Winter Steelhead Hatchery Program | WDFW | WDFW, MIT, PSRE, DJ |
| Green River Summer Steelhead Hatchery Program | WDFW | WDFW, PSRE, DJ |

[1]WDFW = Washington Department of Fish and Wildlife; MIT = Muckleshoot Indian Tribe; SIT = Suquamish Indian Tribe; BIA = Bureau of Indian Affairs; PSRE = Puget Sound Recreational Enhancement Fund; DJ = Dingell-Johnson Federal Aid in Sport Fish Restoration Act Fund; PSSC = Puget Sound Skills Center.

## 1.1. Background

NMFS prepared the biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402. The opinion documents consultation on the actions proposed by NMFS and the BIA. We also completed an Essential Fish Habitat (EFH) consultation. It was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq.*) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through the NOAA Institutional Repository approximately two weeks after signature. A complete record of this consultation is on file at the Sustainable Fisheries Division (SFD) of NMFS in Portland, Oregon.

## 1.2. Consultation History

The first hatchery consultations in Puget Sound followed the listing of the Puget Sound Chinook Evolutionarily Significant Unit (ESU) under the ESA (64 FR 14308, March 24, 1999). In 2005, WDFW and the Puget Sound Tribes ("co-managers") completed two resource management plans (RMP) as the overarching frameworks for 114 HGMPs, including HGMPs for Green River hatchery programs (PSIT and WDFW 2004; PSTT and WDFW 2004). The HGMPs described how each hatchery program would operate including effects on listed fish in the Puget Sound region. In 2004, the co-managers submitted the two RMPs and 114 HGMPs to NMFS for ESA review under limit 6 of the ESA 4(d) rule (50 C.F.R. 223.203). Of the 114 HGMPs, 75 were state-operated, including 27 Chinook salmon programs, 22 coho salmon programs, 2 pink salmon programs, 4 chum salmon programs, 2 sockeye salmon programs, and 18 steelhead programs. The Puget Sound Tribes submitted 38 HGMPs, including 14 for Chinook salmon, 13 for coho salmon, 9 for chum salmon, and 2 for steelhead. USFWS submitted one HGMP for its coho salmon program at Quilcene National Fish Hatchery.

Subsequent to the submittal of the plans to NMFS, the Puget Sound Steelhead Distinct Population Segment (DPS) was listed as "threatened" (72 FR 26722, May 11, 2007). On September 25, 2008, NMFS issued a final 4(d) rule adopting protective regulations for the listed Puget Sound steelhead DPS (73 FR 55451). In the final rule, NMFS applied the same 4(d) protections for steelhead as were already adopted for other ESA-listed Pacific salmonids in the region. Accordingly, the co-manager hatchery plans are now also subject to review for effects on listed steelhead.

After reviewing the HGMPs for the Green River Basin hatchery programs, NMFS determined that they included information sufficient for the agency to complete its determination of whether the HGMPs addressed criteria specified under limit 6 of the ESA (4)d Rule [73 FR 55451 (September 25, 2008)] (Jones 2015; 2016a). For HGMPs determined through NMFS review to satisfy the 4(d) Rule criteria (and, for state HGMPs submitted pursuant to Limit 5 of the Rule, approved), ESA section 9 take prohibitions will not apply to hatchery activities managed in accordance with the plans.

This biological opinion is based on information provided in the Green River Basin HGMPs (Muckleshoot Indian Tribe and Suquamish Indian Tribe 2017; WDFW 2013; WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2017), and addenda created from discussions between NMFS and the co-managers throughout the consultation (Muckleshoot Indian Tribe et al. 2019; Schaffler 2019; Scott 2018). An HGMP for a Soos Creek Hatchery early winter steelhead program in the Green River Basin had been submitted by the co-managers to NMFS for review and approval in 2014 (Scott 2014), but was subsequently withdrawn from consideration by the co-managers (K. Cunningham, WDFW, email sent to Isabel Tinoco, Muckleshoot Indian Tribe, regarding Soos Creek early winter steelhead; and I. Tinoco, Muckleshoot Indian Tribe, email sent to Steve Leider, NMFS, July 8, 2015, regarding Soos Creek early winter steelhead).

## 1.3. Proposed Action

"Action," as applied under the ESA, means all activities, of any kind, authorized, funded, or carried out, in whole or in part, by Federal agencies. For EFH consultation, "Federal action" means any on-going or proposed action authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). Because the actions of the Federal agencies are subsumed within the effects of the hatchery program and any

associated research, monitoring and evaluation, the details of each hatchery program are summarized in this section.

The Proposed Actions are: (1) NMFS' determination under limit 6 of the ESA 4(d) rules; and (2) The BIA's ongoing disbursement of funds for operation and maintenance of the tribal hatchery programs listed in Table 1. The objective of this Proposed Action is to document the determination of likely effects on ESA-listed salmon and steelhead and their designated critical habitat resulting from operation and maintenance of the seven salmon and steelhead hatchery programs operating in the Green River Basin. This document evaluates whether the Proposed Actions comply with the provisions of Section 7(a)(2) of the ESA and ESA Section 4(d) Limit 6 for resource management plans developed jointly by states and tribes within the *U.S. v. Washington* construct. The duration of the Proposed Action is intended to be ongoing.

The purpose of the hatchery programs is to: (1) help meet adult fish loss mitigation responsibilities from past and on-going human developmental activities in the Green River Basin, and from climate change; (2) Expand the prey base for the endangered Southern Resident Killer Whale DPS; (3) Provide salmon and steelhead for harvest for regional recreational and commercial fisheries, tribal treaty fisheries, and Pacific Salmon Treaty harvest sharing agreements with Canada.

The programs have been designed to operate adaptively in response to infrastructure changes, habitat changes, and natural-origin population responses in the Green River watershed. Program modifications are divided amongst four phases: (1) Current infrastructure, (2) Operation of the Fish Restoration Facility, (3) Downstream fish passage provided at Howard Hanson Dam (HHD), (4) Self-sustaining, harvestable, naturally-spawning, natural-origin populations of listed species above HHD. The co-managers have included phases three and four in the Proposed Action to document the long-term intent of the programs, but recognize that information pertinent to the analysis of effects is likely to arise before transition to phases three and four occurs. Thus, the co-managers will contact NMFS prior to moving from phase two to phase three to enable an accurate analysis of the two latter phases on listed species in the Green River watershed.

### 1.3.1. Proposed hatchery broodstock collection

Details of broodstock origin, collection and number for all programs are listed below in Table 2. The Soos Creek Fall Chinook salmon program will be operated as a genetically linked program, with returns from the integrated component used as broodstock for the segregated component. NMFS defines "integrated" as a program that uses natural-origin fish in the broodstock, and "segregated" or "isolated" as a program that only uses hatchery-origin fish in the broodstock. Once the Fish Restoration Facility (FRF) comes online, this facility will coordinate with the Soos Creek program to produce more fish within the segregated component. More details specific to the two Chinook salmon programs are outlined in Table 3 and Table 4.

The early summer steelhead (ESS) program uses a stock that originates from the Columbia River (Skamania). As a measure to eliminate the potential genetic effects of out of Puget Sound ESS production on the Green River winter steelhead population, the co-managers have included as part of the proposed action that they will transition the Soos Creek Hatchery ESS program to a within Puget Sound summer steelhead stock within 12 spawn years of opinion signature. The details of the transition are yet to be decided by the co-managers.

**Table 2. Broodstock collection details. FRF = Fish Restoration Facility; SCH = Soos Creek Hatchery; IC = Icy Creek trap, PP = Palmer Ponds trap; KCC = Keta Creek Complex; TPU = Tacoma Public Utilities fish collection facility; MCH = Miller Creek Hatchery trap; MTC = Marine Technology Center trap.**

<table>
<tr><th>Program</th><th>Local source</th><th>Collection Location(s)</th><th>Collection Method</th><th>Collection/ Holding Target</th><th>Collection Duration</th><th>pNOB</th></tr>
<tr><td>Soos Creek Fall[1] Chinook: integrated component</td><td>Hatchery and natural</td><td rowspan="3">SCH, IC, PP, TPU, FRF, Green River</td><td rowspan="3">Ladder, weir and trap, seine, net</td><td>760[1]</td><td>August-October</td><td>up to 1</td></tr>
<tr><td>Soos Creek Fall[1] Chinook: segregated component</td><td rowspan="2">Hatchery</td><td rowspan="2">4,100</td><td rowspan="2">August-October</td><td rowspan="2">0</td></tr>
<tr><td>FRF Fall Chinook[1]</td></tr>
<tr><td>FRF Coho</td><td rowspan="4">Hatchery and natural</td><td rowspan="4">TPU, FRF KCC, SCH, TPU, MTC, MCH</td><td rowspan="4">Ladder, weir and trap</td><td rowspan="4">4,580</td><td rowspan="4">October-December</td><td>up to 1</td></tr>
<tr><td>KCC Yearling Coho</td><td>up to 1</td></tr>
<tr><td>Soos Creek Coho</td><td>up to 1</td></tr>
<tr><td>MTC Coho</td><td>0</td></tr>
<tr><td>KCC Fall Chum</td><td>Hatchery and natural</td><td>KCC</td><td>Ladder and trap</td><td>5,000</td><td>October-December</td><td>up to 1</td></tr>
<tr><td>FRF Steelhead[2]</td><td>Hatchery and natural</td><td rowspan="2">TPU, FRF, SCH, IC, PP Green River</td><td rowspan="2">Ladder, weir and trap; Angling, seine, net</td><td rowspan="2">280</td><td>December-April</td><td>up to 1</td></tr>
<tr><td>Green River Native Winter Steelhead[2]</td><td>Hatchery and natural</td><td>December-April</td><td>up to 1</td></tr>
<tr><td>Green River Summer Steelhead[3]</td><td>Hatchery: Skamania stock</td><td>IC, SCH</td><td>Weir and trap</td><td>100</td><td>July-January</td><td>0</td></tr>
</table>

[1] Excess natural-origin fall Chinook salmon collected for broodstock will be released back into the mainstem Green River or Soos Creek. The fall Chinook salmon programs will use no more than 40% of the projected natural-origin return post fisheries for broodstock.

[2] Excess natural-origin steelhead broodstock will be released back into the mainstem Green River. The winter steelhead programs will use no more than 20% of the projected natural-origin return post fisheries for broodstock, and target a minimum pNOB of 50%.

**Table 3. Summary of Green River Chinook salmon broodstock management for Phases 1 and 2: NOR = natural-origin returns; HOR = hatchery-origin returns; SCH = Soos Creek Hatchery; TPU = Tacoma Public Utilities fish collection facility; FRF = Fish Restoration Facility.**

| Phase | Projected NOR Post Fisheries | Use of NOR at SCH[1] | Passage of NOR at Soos Creek | TPU Trap | Transport from SCH to Green River |
|---|---|---|---|---|---|
| 1 | < 500 | Discuss use of NOR | No NOR passed upstream | Return HOR when < 4,423 natural spawners; Discuss use of NOR | Transport HOR to achieve 4,423 natural spawners. Type of transport fish in priority order: 1) NOR 2) integrated HOR[3] 3) segregated HOR |
| | 500 - 1,700 | Prioritize NOR for integrated component[2] | Up to 12% post-fishery NOR passed upstream[4] | Return HOR when < 4,423 natural spawners; Collect NOR for integrated component | |
| | > 1,701 | | Up to 200 NOR passed upstream | | |
| **Phase** | **Projected NOR Post Fisheries** | **Use of NOR at SCH[1]** | **Passage of NOR at Soos Creek** | **TPU Trap & FRF** | **Transport from SCH to Green River** |
| 2 | < 500 | Discuss use of NOR | No NOR passed upstream | Collect HOR for FRF; Return surplus HOR to Green River when < 4,423 natural spawners; Discuss use of NOR | Transport HOR to achieve 4,423 natural spawners. Type of transport fish in priority order: 1) NOR 2) integrated HOR[3] 3) segregated HOR |
| | 500 - 1,700 | Prioritize use of collected NOR for integrated component[2] | Up to 12% of projected post-fishery NOR passed upstream[4] | Collect HOR for FRF; Return surplus HOR to Green River when < 4,423 natural spawners; Collect NOR for integrated component | |
| | > 1,701 | | Up to 200 NOR passed upstream | | |

[1] The use of natural-origin Chinook for broodstock in hatchery programs cannot exceed 40% of the projected post fishery return.
[2] When the projected post-fishery NOR exceeds 500, the priorities for the NORs returning to Soos Creek, the TPU trap, or collected from other locations are as follows: 1) Soos Creek Hatchery integrated program; 2) passage to Soos Creek; and 3) transport to Green River.
[3] The HORs from the integrated component will be prioritized for use as broodstock for the segregated program.
[4] The maximum percentage of NOR passed upstream is abundance dependent as described in Table 4.

The Soos Creek Hatchery weir on Big Soos Creek is operated seasonally to collect Chinook and coho salmon broodstock, as well as summer- and winter steelhead, and the weir would be a temporary barrier to upstream and downstream fish passage. In-channel weirs and traps would also be seasonally operated in association with the Icy Creek, Flaming Geyser, Palmer Ponds, Keta Creek Complex, and the Marine Technology Center facilities. None of the structures used by these facilities are located in surface water areas where listed fish species are present.

Alternative methods may be needed to capture broodstock because of the unknowns associated with the mechanics of the Soos Creek Hatchery rebuild, including how adults will respond to the new fish ladder, weir, and adult ponds in the range of low to high water conditions. These methods could involve seining or netting the area below the new fish ladder entrance down to the bridge at the lower end of the hatchery property, and/or in-river collections at various access points on the Green River to collect natural-origin fish.

**Mating Protocols (listed fish only)**

Chinook salmon used for broodstock would be selected for spawning randomly as the fish mature, and representatively across the maturation period for the fall Chinook salmon population. If the seasonal egg-take goal for the program is met, but later-spawning females are available, eggs will be collected to represent the later portion of the run, and these eggs will replace the portion of the earlier, segregated eggs collected earlier. All male Chinook salmon collected, including jacks, would be considered for spawning. Males would be chosen randomly from the held population, and jacks would be incorporated into spawning at a rate of up to 2% of spawned males. Eggs from each female are collected in a separate container and mixed with milt from one male (pairwise spawning). If the male used is not ripe or has little milt, another male is used to assure fertilization.

For the native steelhead programs, broodstock would be selected randomly as the fish mature, and representatively across the maturation period for the steelhead population. Males may be used more than once if primary males are not available on a given spawn day. When this occurs, males would be used no more than four times as primary spawners. Fertilization occurs using factorial crosses, preferably 2x2 or 2x3, when possible, but other combinations may be used. Pairwise spawning would only occur on days when only one female available for spawning.

### 1.3.2. Proposed Adult Management

For the Chinook salmon programs during phases 1 and 2, the co-managers propose to remove hatchery-origin adults from the various collection sites once the total of naturally spawning fish exceeds 4,423 fish (Table 3). The co-managers also propose to maintain the area in Soos Creek above the weir as a natural production emphasis area by only passing natural-origin adults above the weir. The co-managers will first use any natural-origin Chinook salmon collected in the integrated component of the Soos Creek program up to a 40% use limit on the natural-origin return. Any additional natural-origin adults will then be used to pass above the Soos Creek weir according to a detailed scale, with no more than 200 adults annually (Table 4). In years where natural-origin returns are fewer than 500 fish, the co-managers will discuss adult management with NMFS.

During phase 1, the native winter steelhead program is intended to meet an escapement goal of 2,003 and has no need to manage adults as all adults returning from this program are intended to spawn

naturally. During phase 2, the FRF steelhead program intends to release up to 100 returning hatchery-origin adults into Newaukum Creek specifically, and only intends to re-release hatchery-origin adults into the remainder of the Green River Basin to meet an escapement goal of 2,003 spawners (hatchery and natural-origin combined).

None of the other programs propagating non-listed fish species propose to remove adults other than for broodstock purposes and as a result of fisheries.

**Table 4. Adult natural-origin Chinook passage above Soos Creek weir based on projected post-fish natural-origin abundance.**

| Projected Post- Fishery NOR | Maximum Passed Upstream | |
|---|---|---|
| | Number | Percent |
| 500 | 30 | 6 |
| 600 | 44 | 7 |
| 700 | 58 | 8 |
| 800 | 73 | 9 |
| 900 | 87 | 10 |
| 1,000 | 101 | 10 |
| 1,100 | 115 | 10 |
| 1,200 | 129 | 11 |
| 1,300 | 143 | 11 |
| 1,400 | 158 | 11 |
| 1,500 | 172 | 11 |
| 1,600 | 186 | 12 |
| 1,700 | 200 | 12 |
| > 1,700 | 200 | |

### 1.3.3. Proposed hatchery rearing and juvenile release

The details of hatchery juvenile rearing and release, including release numbers, marking/tagging, rearing and release locations, and release timing can be found in Table 5. In the first phase, each program will continue to release fish according to the currently available infrastructure. In phase two, the fish restoration facility comes online, and allows for some juvenile Chinook salmon released at Palmer Ponds to be moved to the FRF. Additional coho and steelhead releases will also take place at this site. In phase three, some of the fish from the FRF site are released upstream of HHD to recolonize salmonid habitat, when recolonization is likely to be successful. In phase four, the releases of fish from the FRF facility upstream of HHD may cease once self-sustaining, naturally-spawning coho, steelhead, and fall Chinook salmon populations are established. Any production required for testing of fish passage at HHD would be in addition to the production detailed in Table 5.

Some additional detail on fish health protocols follows. Prior to hatching, dead eggs are picked on a regular schedule (approximately two times per week) to discourage the spread of fungus. During rearing, regular fish health inspections are conducted. If disease agents are suspected or identified, more frequent inspections will be conducted. Prior to release, final pre-release fish health inspections are conducted by

these offices for their respective programs. All fish production is conducted according to the Northwest Indian Fisheries Commission and WDFW fish health policy (NWIFC and WDFW 2006). A few exceptions to this policy occur when fish are transferred as eyed-eggs to various co-operative groups for subsequent rearing and release. For these release groups, which are generally small (< 150,000), co-operative groups contact WDFW personnel if fish start to behave abnormally or if mortality occurs, and fish health specialists are then contacted as needed.

**Table 5. Proposed annual release protocols for each program. AD = adipose fin clip; CWT = coded-wire tag; BWT = blank-wire tag; SCH = Soos Creek Hatchery, IC = Icy Creek Rearing Ponds, FGP = Flaming Geyser Ponds, KCC = Keta Creek Complex, MCH = Miller Creek Hatchery, MTC = Marine Technology Center, FRF = Fish Restoration Facility, HHD = Howard Hanson Dam.**

| Program | Number, life stage, and size (fpp) | Marking and Tagging | Egg incubation and rearing Location | Release Location | Volitional Release? | Release Time |
|---|---|---|---|---|---|---|
| Soos Creek Fall Chinook | 3,200,000 subyearling; 80 | 88% ad; 6% ad and CWT; 6% CWT only | SCH | SCH[2] | No | Early-May to June |
| | 1,000,000 subyearling; 80 | 100% BWT | SCH | SCH | No | |
| | 2,000,000 subyearling; 45 | 100% ad | SCH, FRF[3] | Palmer Ponds, SCH, FRF, IC[3] | Yes | June to July 4 |
| | 300,000 yearling; 10 | 100% ad | SCH | IC | Yes | April |
| FRF Fall Chinook[1] | 600,000 subyearling; 65 | 100% ad; 10% CWT | FRF | FRF, Palmer Ponds | Yes | June |
| FRF Coho[1] | 600,000 yearling; 14 | 100% ad; 10% CWT | FRF | FRF | Yes | April to May 15 |
| KCC Coho | 1,000,000 yearling; 14 | 100% ad; 10% ad and CWT | KCC | KCC | Yes | April to May 10 |
| | 1,000,000 yearling; 9 | 100% ad; 13% ad and CWT | KCC | Elliott Bay netpens | Yes | June |
| | 50,000 yearling; 14 | None | KCC | FRF site | Yes | April to May 15 |
| Soos Creek Coho | 600,000 yearling; 17 | 85% ad; 7.5% ad and CWT; 7.5% CWT | SCH | SCH | Yes | April to May 10 |
| | 30,000 yearling; 15 | 100% ad | SCH | Des Moines Ponds | No | June |
| | 120,000 fed fry; 1500 | None | MCH | Miller, Walker and Des Moines Creeks | No | January |
| KCC Fall Chum | 5,000,000 fry; 450-150 | None | KCC | KCC | Yes | March 1 to May 15 |
| MTC Coho | 10,000 yearling; 11 | 100% ad | MTC | MTC | No | April |
| FRF steelhead[1] | 250,000 yearling; 5-10 | 100% ad; 10% CWT | FRF | FRF | No | Mid-April to June 30 |
| Green River Native Winter Steelhead | 23,000 yearling; 8 | 100% BWT | SCH | IC | Yes | May |
| | 15,000 yearling; 8 | 100% BWT | SCH | FGP | Yes | |
| | 17,000 yearling; 8 | 100% BWT | SCH | Palmer Ponds | Yes | |
| Green River Summer Steelhead | 100,000 yearling; 5 | 100% ad | SCH | SCH, IC[4] | Yes[5] | Mid-April to May |

[1] These programs are not yet operational.
[2] Up to 1 million subyearlings may undergo final rearing and release at Palmer Ponds as needed as agreed to by the co-managers annually.
[3] Palmer Ponds is the targeted release site for these fish, but other sites listed here may be used as needed or available as agreed to by the co-managers annually. Under phase 2, when the FRF becomes operational, a portion of this release may be reared and released at the FRF.
[4] With co-manager agreement the proportion of the release that occurs at each release site may vary anywhere from 0-1.
[5] Smolts that do not migrate from rearing ponds after a four-week period are collected and planted into non-anadromous waters.

### 1.3.4. Proposed disposition of excess juvenile and adult hatchery fish, broodstock and post-spawned carcasses

Egg-take is carefully managed to minimize the likelihood of collecting surplus eggs or raising surplus fry. However, in years of high within-hatchery survival, juvenile production levels higher than the proposed release numbers may occur. The co-managers plan to limit production to no more than 110% of levels described in the HGMPs and in Table 5; an overage of 10% is anticipated to be a rare occurrence. If the running 5-year average production (beginning in the release year that NOAA makes a determination on the program) for a species-stage in the Green River is more than 105% of the level described, the co-managers will notify NMFS.

**Table 6. Disposition of excess adult hatchery fish, broodstock and post-spawned carcasses.**

| Program | Disposition |
|---|---|
| Soos Creek Fall Chinook | • Release hatchery-origin adults into the Green River to achieve the equilibrium escapement goal of 4,423 fish.<br>• Spawned and un-spawned carcasses will be used for nutrient enrichment, donated, and/or sold to a carcass buyer. |
| FRF Fall Chinook | • Release hatchery-origin adults into the Green River to achieve the equilibrium escapement goal of 4,423 fish.<br>• Spawned and un-spawned carcasses will be used for nutrient enrichment, donated to tribal members, and/or sold to a carcass buyer. |
| FRF Coho | • Un-spawned adults will be used for nutrient enhancement, donated to tribal members (small quantity), and/or sold to a carcass buyer. |
| KCC Yearling Coho | • Un-spawned adults will be transferred to the spawning grounds, donated to tribal members (small quantity), and/or sold to a carcass buyer. |
| Soos Creek Coho | • Release up to 600 natural- and/or hatchery-origin adults into Big Soos Creek |
| MTC Coho | • Un-spawned adults are killed and frozen on-site for later dissection by students as per the class curriculum. |
| KCC Fall Chum | • Un-spawned adults will be transferred to the spawning grounds, and spawned and unspawned carcasses will be used for nutrient enrichment, donated, or sold to a carcass buyer. |
| FRF Steelhead | • Release natural- and/or hatchery-origin adults into Green River Basin tributaries to achieve the escapement goal of 2,003 adults.<br>• Carcasses will be used for nutrient enrichment, donated, or sold to a carcass buyer. |
| Green River Native Winter Steelhead | • Spawned carcasses will be used for nutrient enrichment, donated, or sold to a carcass buyer. |
| Green River Summer Steelhead | • Spawned and un-spawned carcasses will be used for nutrient enrichment, donated, or sold to a carcass buyer. |

### 1.3.5. Proposed research, monitoring, and evaluation (RM&E)

All of the Green River Basin hatchery programs include monitoring, evaluation, and adaptive management measures designed to monitor and reduce incidental effects on natural-origin fish populations:

- An adult Chinook salmon monitoring program (stream surveys and biological sampling) would be conducted annually to document HOR/NOR ratios, spawning contributions, spatial structure, diversity, age, sex, and size of natural- and hatchery-origin fish escaping to natural spawning areas and the hatcheries in the Green River Basin.
- Monitoring of Chinook salmon escapement to Green River Basin natural spawning areas to estimate the number of clipped and/or tagged fish escaping to the Green River and basin tributaries each year.
- Foot and boat spawning ground surveys would be implemented to count spawning fish and sample Chinook salmon carcasses for scales, adipose-fin clips, CWT's, and potentially tissues for DNA analysis.
    - The same level and types of biological sampling would be implemented for fish escaping to the hatcheries and collected as broodstock.
- An adult steelhead monitoring program (spawning ground surveys) conducted annually to document abundance and spatial structure of steelhead escaping to natural spawning areas and hatcheries.
- Steelhead genetic samples will be collected and analyzed annually to compare the number of hybrid and hatchery-ancestry.

### 1.3.6. Proposed operation and maintenance of hatchery facilities

**Table 7. Details for those facilities that divert water for hatchery operations; NA = not applicable; NM = not measured.**

| Facilities | Surface Water (cfs) | Ground/Spring Water (cfs) | Water Diversion Distance (km) | Water source | Discharge Location | Meet NMFS Screening Criteria (Criteria year)? | NPDES Permit # | WDOE Water Right Permit # |
|---|---|---|---|---|---|---|---|---|
| Soos Creek Hatchery | 37.64 | 0.71 | 0.02 | Big Soos Creek | Big Soos Creek | Yes (1995/1996) | WAG 13-3014 | S1-000382 (0.71 cfs), S1-000449 (2.64 cfs), S1-21222 (5.0 cfs), and S1-*19055 (30.0 cfs) |
| Icy Creek Rearing Ponds | 20.0 | NA | <0.03 | Icy Creek | Icy Creek | No | WAG 13-3013 | S1-22710 |
| Palmer Rearing Ponds | NA | 15.0 | NA | NA | Green River | No | WAG 13-3002 | S1-*20296 |
| Flaming Geyser Ponds | 1.5 | NA | 0.05 | Cristy Creek | Cristy Creek | Yes (2011) | NA[1] | S1-24715 |
| Fish Restoration Facility | Up to 27 | Up to 2 | 1.6 | Green River | Green River | Yes (2011) | To be obtained as required | To be obtained |
| Marine Technology Center | < 5.0 | NA | 0.05 | North Creek | Puget Sound | No | NA[1] | Yes[2] |
| Keta Creek Complex | 10.55 | 2.0 | 0.3 | Crisp Creek | Crisp Creek | Yes (1995-1996) | WAG 13-0020 | S1-23839, S1-24508, S1-22503, and S1-22989 |
| Miller Creek Hatchery | NA | 0.04 | NA | Miller Creek | Miller Creek | NA | NA[1] | Yes[3] |
| Elliott Bay Net Pens | NM[4] | NA | NA | Puget Sound | NA | NA | WAG 13-2002 | NA |
| Des Moines Net Pens | NM[4] | NA | NA | Puget Sound | NA | NA | NA | NA |

[1] Release less than 20,000 pounds of fish per year and/or feed fish less than 5,000 pounds of fish feed per year and do not require a NPDES permit.
[2] The Marine Technology Center surface water withdrawal rights are regulated under a water rights permit deeded to the Puget Sound Skills Center through a lease with the city of Burien.
[3] The Miller Creek Hatchery water right is held by SWSSD.
[4] Net pens use seawater, passively supplied through tidal flow, for rearing coho salmon, and the amount coursing through the net-pen is not measurable relative to the total amount of water in Puget Sound.

### 1.4. Interrelated and Interdependent Actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration. In determining whether there are interrelated and interdependent actions that should be considered in this consultation, NMFS has considered whether fisheries impacting Green River Hatchery program fish are interrelated or interdependent actions that are subject to analysis in this opinion.

Recreational and tribal fisheries targeting salmon and steelhead produced by the proposed hatchery programs occur within the Green River watershed as well as Puget Sound terminal area marine waters of Elliott Bay. The proposed hatchery programs analyzed in this opinion also contribute to regional fisheries outside of the Green River watershed and marine terminal areas. The effects of all fisheries that incidentally harvest ESA-listed fish species originating from the action area hatcheries, including fisheries directed at WDFW hatchery and Muckleshoot and Suquamish tribal hatchery salmonids, have been evaluated through a separate NMFS ESA consultation (NMFS 2016a; NMFS 2017a; NMFS 2018a) and are included in the Environmental Baseline (see Section 2.4.4).

## 2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the USFWS, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an Incidental Take Statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

### 2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. "To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species or reduce the value of designated or proposed critical habitat (50 CFR 402.02).

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or

biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214, February 11, 2016).

The designations of critical habitat for the species considered in this opinion use the terms primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414, February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. We use the term PCE as equivalent to PBF or essential feature, due to the description of such features in applicable recovery planning documents.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat.

*Identify the range-wide status of the species and critical habitat*
This section describes the status of species and critical habitat that are the subject of this opinion. The status review starts with a description of the general life history characteristics and the population structure of the ESU/DPS, including the strata or major population groups (MPG) where they occur. NMFS has developed specific guidance for analyzing the status of salmon and steelhead populations in a "viable salmonid populations" (VSP) paper (McElhany et al. 2000). The VSP approach considers four attributes, the abundance, productivity, spatial structure, and diversity of each population (natural-origin fish only), as part of the overall review of a species' status. For salmon and steelhead protected under the ESA, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of listed species, NMFS reviews available information on the VSP parameters including abundance, productivity trends (information on trends, supplements the assessment of abundance and productivity parameters), spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of the populations and ESU/DPS, and the limiting factors and threats. To source this information, NMFS relies on viability assessments and criteria in technical recovery team documents, ESA Status Review updates, and recovery plans. We determine the status of critical habitat by examining its PBFs. Status of the species and critical habitat are discussed in Section 2.2.

*Describe the environmental baseline in the action area*
The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area* on ESA-listed species. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.4 of this opinion.

*Analyze the effects of the proposed action on both the species and their habitat*
Section 2.5 first describes the various pathways by which hatchery operations can affect ESA-listed salmon and steelhead, then applies that concept to the specific programs considered here.

*Cumulative effects*
Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur

within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.6 of this opinion.

*Integration and synthesis*
Integration and synthesis occurs in Section 2.7 of this opinion. In this step, NMFS adds the effects of the Proposed Action (Section 1.3) to the status of ESA protected populations in the Action Area under the environmental baseline (Section 2.4) and to cumulative effects (Section 2.6). Impacts on individuals within the affected populations are analyzed to determine their effects on the VSP parameters for the affected populations. These impacts are combined with the overall status of the MGP to determine the effects on the ESA-listed species (ESU/DPS), which will be used to formulate the agency's opinion as to whether the hatchery action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat.

*Jeopardy and adverse modification*
Based on the Integration and Synthesis analysis in Section 2.7, the opinion determines whether the proposed action is likely to jeopardize ESA protected species or destroy or adversely modify designated critical habitat in Section 2.8.

*Reasonable and prudent alternative(s) to the proposed action*
If NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a RPA or RPAs to the proposed action.

## 2.2. Range-wide Status of the Species and Critical Habitat

This opinion examines the status of each species and designated critical habitat that would be affected by the Proposed Action. The species and the designated critical habitat that are likely to be affected by the Proposed Action, and any existing protective regulations, are described in Table 8. Status of the species is the level of risk that the listed species face based on parameters considered in documents such as recovery plans, status reviews, and ESA listing determinations. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the status and conservation value of critical habitat in the action area and discusses the current function of the essential physical and biological features that help to form that conservation value.

**Early Summer Steelhead Program**

Early summer steelhead (ESS) in Puget Sound were derived about 50 years ago from transplanted Columbia River basin Washougal and Klickitat River stock. The ESS program in the Green River system was initiated in the 1960s, with releases from Palmer Ponds from 1969 through 2009 (WDFW 2015). In order to produce a local ESS stock, broodstock collection, egg incubation, and rearing was shifted to the Soos Creek Hatchery in 2002. Rearing and releases from the Icy Creek rearing ponds began in 1999 with broodstock collection added in 2012. Intermittent smolt releases from Flaming Geyser occurred from 2004 through 2010. From 2002 through 2015, an average of 76,200 ESS smolts were released into the Green River Basin annually. There has been some limited natural production by feral ESS in the Green River. Although Hard et al. (2007) estimated that only 3% of the returning ESS hatchery population spawns naturally each year, in modeling potential genetic risks to natural steelhead, WDFW has assumed that 20% to 30% of escaping ESS spawn naturally each year (WDFW 2015). The remainder of returning ESS are collected at the hatchery racks or are harvested in freshwater fisheries.

## 2.5. Effects on ESA Protected Species and on Designated Critical Habitat

This section describes the effects of the Proposed Action, independent of the Environmental Baseline and Cumulative Effects. The methodology and best scientific information NMFS follows for analyzing hatchery effects is summarized in Appendix A and application of the methodology and analysis of the Proposed Action is in Section 2.5.2. The "effects of the action" means the direct and indirect effects of the action on the species and on designated critical habitat, together with the effects of other activities that are interrelated or interdependent, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur. The Proposed Action, the status of ESA-protected species and designated critical habitat, the Environmental Baseline, and the Cumulative Effects are considered together later in this document to determine whether the Proposed Action is likely to appreciably reduce the likelihood of survival and recovery of ESA protected species or result in the destruction or adverse modification of their designated critical habitat.

### 2.5.1. Factors That Are Considered When Analyzing Hatchery Effects

NMFS has substantial experience with hatchery programs and has developed and published a series of guidance documents for designing and evaluating hatchery programs following best available science (Hard et al. 1992; Jones 2006; McElhany et al. 2000; NMFS 2004b; NMFS 2005b; NMFS 2008a; NMFS 2011b). For Pacific salmon, NMFS evaluates extinction processes and effects of the Proposed Action beginning at the population scale (McElhany et al. 2000). NMFS defines population performance measures in terms of natural-origin fish and four key parameters or attributes; abundance, productivity, spatial structure, and diversity and then relates effects of the Proposed Action at the population scale to the MPG level and ultimately to the survival and recovery of an entire ESU or DPS.

"Because of the potential for circumventing the high rates of early mortality typically experienced in the wild, artificial propagation may be useful in the recovery of listed salmon species. However, artificial propagation entails risks as well as opportunities for salmon conservation" (Hard et al. 1992). A Proposed Action is analyzed for effects, positive and negative, on the attributes that define population viability: abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS and designated critical habitat "will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes" (70 FR 37215, June 28, 2005). The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. "Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU".

NMFS' analysis of the Proposed Action is in terms of effects it would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information available. This allows for quantification (wherever possible) of the effects of the six factors of hatchery operation on each listed species, which in turn allows the combination of all such effects with other effects accruing to the species to determine the likelihood of posing jeopardy.

Information that NMFS needs to analyze the effects of a hatchery program on ESA-listed species must be included in an HGMP. Draft HGMPs are reviewed by NMFS for their sufficiency before formal review and analysis of the Proposed Action can begin. Analysis of an HGMP or Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on six factors. These factors are:

1. The hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock
2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities
3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, migratory corridor, estuary and ocean
4. RM&E that exists because of the hatchery program
5. The operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program
6. Fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds

NMFS' analysis assigns an effect category for each factor (negative, negligible, or positive/beneficial) on population viability. The effect category assigned is based on: (1) an analysis of each factor weighed against the affected population(s) current risk level for abundance, productivity, spatial structure and diversity; (2) the role or importance of the affected natural population(s) in salmon ESU or steelhead DPS recovery; (3) the target viability for the affected natural population(s) and; (4) the Environmental Baseline, including the factors

currently limiting population viability. For more information on how NMFS evaluates each factor, please see Appendix A.

### 2.5.2. Effects of the Proposed Action

#### 2.5.2.1. Factor 1. The hatchery program does or does not remove fish from the natural population and use them for broodstock

**Chinook Salmon Broodstock**

Both of the fall Chinook salmon hatchery programs remove fish from the local natural population for broodstock, leading to a negative effect for Chinook salmon. The 2013 to 2017 natural-origin adult escapement to the Green River has averaged 1,842 fish, and ranged from 806 to 3,588 fish (WDFW Score). The average number of adult natural-origin fish removed from the river for broodstock from 2013 through 2017 was 498 fish, about 27% of the average natural-origin return. During this time, removal for the hatchery program ranged from 18 to 35% of the natural-origin return. In the Proposed Action through all four phases, the co-managers propose to limit the removal of natural-origin Chinook salmon for hatchery program broodstock to 40% of the natural-origin return.

NMFS believes this to be an acceptable level of removal because the Chinook programs are closely linked to each other through their broodstock practices and allow some spawning by hatchery-origin returns. Thus, some genetic material from those natural-origin Chinook salmon spawned in the hatchery is likely to remain in the natural environment. In addition, all of the fish used for broodstock are spawned in the hatchery, leading to higher egg-to-smolt survival rates than in the wild. The net effect is anticipated to be an increase in abundance—potential adverse effects of naturally spawning hatchery fish are discussed in the following subsection.

**Winter Steelhead Broodstock**

Both of the winter steelhead hatchery programs remove fish from the local natural population for broodstock, leading to a negative effect for steelhead. From 2014 to 2018, the annual natural-origin return averaged 1,200 fish, and ranged from 622 to 2,111 fish (WDFW 2018a). For both steelhead programs combined, a maximum of 20% of the natural-origin steelhead return may be used as broodstock; this rate is not expected to increase through all four phases. This 20% maximum applied to data from 2014 to 2018 would have provided 240 fish on average for both steelhead programs, and would have ranged from 124 to 422 steelhead.

NMFS believes this to be an acceptable level of removal similar to the reasons described above for Chinook salmon; both steelhead programs are integrated, they allow some spawning by hatchery-origin returns, and all of the fish are spawned in the hatchery, leading to higher egg-to-smolt survival rates than in the wild. In addition, starting in brood year 2010, adult broodstock were live-spawned when possible depending upon fish condition, with spawned fish allowed to recover and return to the stream (WDFW 2017). The net effect is anticipated to be an increase in abundance—potential adverse effects of naturally spawning hatchery fish are discussed in the following subsection. We also anticipate that with passage at HHD potentially opening up new spawning habitat, abundance may increase further into the future.

### 2.5.2.2. Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds

The proposed hatchery programs pose both genetic and ecological risks. There is some benefit to the species from the integrated and genetically linked programs designed to supplement the ESA-listed Chinook salmon and steelhead populations. This supplementation is designed to increase population abundance and productivity by increasing the number of adult returns. In addition, spatial structure and diversity are also likely to be improved through the creation of a few natural-origin Chinook salmon only areas, and the supplementation of hatchery-origin steelhead into Newaukum Creek (see details below).

The coho and chum programs do not have any genetic effects on listed Chinook salmon and steelhead populations because these species do not interbreed. However, the ecological risks of redd superimposition and spawning site competition are likely greater between species, such as coho and Chinook salmon, than between hatchery and natural fish of the same species. Thus, NMFS believes that the net effect of the steelhead and Chinook programs on listed species is beneficial, while the coho and chum programs are likely to have a small negative effect on listed species through ecological effects.

#### 2.5.2.2.1. Genetic Effects

For each program, NMFS considers three major areas of genetic effects: within-population diversity, outbreeding effects, and hatchery-influenced selection. The within-population diversity area covers such topics as effective size and mating protocols. Assessment of the other two categories occurs simultaneously using the pHOS metric. For segregated programs, genetic effects are assessed by considering how many fish from each program may spawn naturally. Because supplementation of the natural population is not typically an objective for this type of program, the number/proportion of hatchery-origin spawners spawning naturally should ideally be zero, since the hatchery population will often be highly adapted to the hatchery environment. However, this is not a realistic goal, as a practical matter, and if the population is to reach necessary abundance levels. As explained in the appendix, the Hatchery Scientific Review Group (HSRG) has developed guidelines for allowable pHOS levels in populations, scaled by the population's conservation importance, recommending a maximum of 5% in "primary" populations, 10% for "contributing" populations, and at a level required to maintain "sustaining" populations (e.g., HSRG 2014).

NMFS has not adopted Hatchery Scientific Review Group (HSRG) gene flow (i.e., pHOS, pNOB, PNI) standards per se. However, at present the HSRG standards and the 5% (or 0.05) stray standard (from segregated programs) from Grant (1997) are the only acknowledged quantitative standards available, so NMFS considers them a useful screening tool. For a particular program, NMFS may, based on specifics of the program, broodstock composition, and environment, consider a pHOS or PNI level to be a lower risk than the HSRG would but,

generally, if a program meets HSRG standards, NMFS will typically consider the risk levels to be acceptable.[4]

#### 2.5.2.2.1.1. *Within-population Diversity*

**Early summer steelhead program**

No interbreeding between the returning summer steelhead and the natural winter steelhead program is intended. Because of low expected reproductive success expected from the few returning hatchery fish that do spawn in the wild (see gene flow analysis below) and the large size of the natural population, we see a negligible risk to the effective size of the natural population through a Ryman-Laikre (Ryman et al. 1995; Ryman and Laikre 1991). In previous Opinions on segregated winter steelhead programs in Puget Sound (e.g., NMFS 2016c) we evaluated their potential to lower effective size due to natural fish production being wasted by spawning with low-fitness hatchery-origin fish and concluded that risk was very low. Given the continued ratios favoring natural-origin steelhead on the spawning grounds, we conclude that this risk for the ESS program will be similarly very low.

**Winter steelhead programs**

In any integrated program the hatchery can potentially have a large impact on local effective size, lowering it through a Ryman-Laikre effect if the broodstock is small and the spawning success of hatchery-origin fish high compared to natural-origin fish. Duchesne and Bernatchez (2002) provided a method for calculating the multi-generational impact of hatchery programs on effective size. Using the pNOB pHOS and escapement counts values in Table 14, and assuming broodstock sizes of 60 for the WDFW program and 280 for the FRF program, we calculate that the current WDFW program reduces the local effective number of breeders by 19,5% (relative to the total of broodstock and natural spawners). With over 1000 spawners per year, even if it is assumed that the $N_b$:$N_c$ is 0.25, the per-generation effective size is over 1000. Once the FRF program is operational, the local effective size reduction is expected to be less than 1% because of the increase in overall (natural spawning + broodstock) number of spawners. Note that the above language uses the term *local*. The calculations assume a closed population. In reality gene flow between salmon and steelhead populations at low levels is common. Analysis using the metapopulation model of Duchesne and Bernatchez (2002) indicate that gene flow of slightly more than 1%, well within the range of what could be expected, would compensate for the local effective size depression that may be caused by the current WDFW program.

**Fall Chinook salmon program**

Unfortunately it is not clear at this point how to apply the Duchesne and Bernatchez approach to capture the complexity of this program. However, given the size of the broodstock relative to

[4] The only exception to date is the case of steelhead programs using highly domesticated broodstocks, where NMFS has imposed more stringent guidelines (NMFS. 2016c. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of Two Hatchery and Genetic Management Plans for Early Winter Steelhead in the Snohomish River basin under Limit 6 of the Endangered Species Act Section 4(d) Rule. April 15, 2016. NMFS Consultation No.: WCR-2015-3441. 189p.).

natural spawning, the operational details are not important. As a worst case scenario, we assumed a broodstock size of 4860, a pNOB of between 0 and 16%, and a pHOS of 95%. Under these conditions, the local $N_b$ reduction will range from 31% to 48%, but assuming a $N_b$:$N_c$ of 25%, annual $N_b$ will still be over 1000 per year, posing no risk to effective size. If the future pNOB, pHOS, and PNI values are achieved as in Table 12, effective size should be even higher.

###### 2.5.2.2.1.2. *Gene Flow Assessment for the Green River Fall Chinook Salmon Population*

The potential negative genetic effects from the Soos Creek Fall Chinook Salmon program, and the FRF Fall Chinook Salmon program to be added in phase 2, are considered along with the demographic benefit of increasing abundance. To perform our analysis, we used a model that considered the best available information for the target population to determine the current and anticipated future PNI of the population based on the applicants' proposed proportion of natural-origin broodstock (pNOB) and the pHOS in natural spawning areas. A PNI of > 0.5 indicates that natural selective forces are equivalent or greater than hatchery-influenced selective forces, and for a tier 2 population under NMFS' Population Recovery Approach is the long-term goal.

Best available data suggests that the current population has a PNI of ~ 0.09, based on average data from 2013-2017 (Table 12). In the future, we anticipate a PNI of ~0.41 during phase 1 if natural-origin returns remain similar to what they have been on average for the last five years. However, Figure 7 depicts what PNI will look like over a range of natural-origin returns. Over the course of the consultation, the co-managers have agreed to some key changes in fall Chinook program operation that are anticipated to result in a substantially higher PNI value compared to the current value. These program modifications are:

- Genetically linked integrated and segregated program components, which requires use of integrated program component returns for segregated component broodstock
- A 40% limit on the removal of natural-origin returns for hatchery program broodstock
- Creation of a natural production emphasis area in Soos Creek, where only natural-origin fish are passed above the weir
- Removals of hatchery-origin fish at existing collection facilities when total spawner abundance is > 4,432 adults
- Shift the integrated program component to Soos Creek Hatchery where adult collection is possible, and fish are likely to home to the site[5] from an off-station release site (Palmer Ponds)
- 100% marking of integrated component fish with a BWT or CWT or a combination of BWT and CWT to enable easy identification as hatchery fish from that program component
- An increase in Soos Creek Hatchery program production from 4.5 to 6.5 million to address the potential shortage of prey for endangered southern resident killer whales (SROTF 2018)

However, these changes cannot be implemented until brood are collected in the fall of 2019. Thus, NMFS expects there will be a period of relatively low PNI, similar to past values, before the benefits of the program modifications can begin to be realized. Integrated adult hatchery-

[5] 11% within basin straying for Soos Creek Hatchery releases compared to 86% within-basin straying for off-station releases, and 55% for Icy Creek yearling releases

origin fish will begin to return in 2022 (age-3 fish) and by 2024 the highly integrated program will have all age classes of returning to fish to supply broodstock to the segregated program. After five-years (2029) all returning segregated fish will have been derived from integrated broodstock.

Phase 2 is defined by the operation of the FRF (see section 1.3), and movement into this phase is anticipated to lead to an increase in PNI through the movement of some off-station fish to the new FRF, which increases the ability to collect returning hatchery-origin adults and remove them from the naturally spawning population. Thus, during phase 2, we anticipate a PNI of 0.42-0.45 if natural-origin returns remain similar to what they have been on average for the last five years depending on how many fish are released from acclimation sites. However, Figure 7 depicts what PNI will look like over a range of natural-origin returns.

We relied on a number of assumptions to populate the parameters of the model. We assumed pre-spawn mortality of 8% for natural-origin fish held for broodstock at the Soos Creek hatchery. We also assumed that SAE (smolt-to-adult-escapement) values for the FRF program and homing would be similar (0.338%) to those we calculated for the currently operating Soos Creek Hatchery program. The model also assumed that 20% of hatchery-origin fish would be removed when the equilibrium escapement goal was projected to be met. In addition, these calculations incorporated an additional 10% of juveniles produced on top of the program release goal.

The co-managers and other stakeholders in the basin have yet to detail what reintroduction entails once passage upstream and downstream of HHD is possible. However, it may be prudent to first conduct recolonization with hatchery-origin fish, which may initially cause a decrease in PNI during phase 3. But, in phase 4, we anticipate an increase in PNI as natural-origin fish are passed upstream of HHD to ensure self-sustaining, natural populations, in effect, creating a second natural production emphasis area above HHD. NMFS recommends that a group composed of federal, state, and tribal entities be formed to plan fish passage and reintroduction well before fish passage is estimated to occur no later than 2030 (NMFS 2018).

**Table 12. Current and proposed Proportionate Natural Influence (PNI) for the Green River Natural fall Chinook salmon Population; pHOS = proportion of hatchery-origin spawners, pNOS = proportion of natural-origin spawners, pNOB = proportion of natural-origin broodstock, pIB = proportion of integrated hatchery-origin broodstock, and pSB = proportion of segregated hatchery-origin broodstock.**

| Time period | Natural-origin Returns | $pNOS_{SC}$[1] | $pNOS_{GR}$[1] | pHOSsc[1] | $pHOS_{I}$[1] | $pHOS_{S}$[1] | Integrated Program | | | Segregated Program | | | PNI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | pNOB | pIB | pSB | pNOB | pIB | pSB | |
| Current[2] | 1,842 | 0.0 | 0.25 | 1.0 | 0.75 | | 0.27 | 0.73 | 0 | 0 | 0.80 | 0.20 | 0.09 |
| Phase 1[3] | 1,842 | 1.0 | 0.11 | 0.0 | 0.04 | 0.85 | 0.97 | 0.03 | 0 | 0 | 0.80 | 0.20 | 0.42 |
| Phase 1[3] | 1,842 | 1.0 | 0.09 | 0.0 | 0.03 | 0.88 | 0.97 | 0.03 | 0 | 0 | 0.80 | 0.20 | 0.41 |
| Phase 2[4] | 1,842 | 1.0 | 0.15 | 0.0 | 0.05 | 0.8 | 0.97 | 0.03 | 0 | 0 | 0.80 | 0.20 | 0.42 |
| Phase 2[4] | 1,842 | 1.0 | 0.25 | 0.0 | 0.09 | 0.66 | 0.97 | 0.03 | 0 | 0 | 0.80 | 0.20 | 0.45 |

[1] The subscripts in the first row of the table are defined as follows: SC=Soos Creek, GR= Green River, I=integrated, S=segregated.
[2] For ease of comparison we divided pHOS into integrated and segregated components, but at this time, both components use natural-origin fish in the broodstock, with pNOB higher in what is designated here as the integrated component (26% of the 27% shown).
[3] The upper phase 1 row assumes 2 million segregated fish are released from acclimation sites, and the lower assumes 3 million segregated fish are released from acclimation sites.
[4] The upper phase 2 row assumes 1 million segregated fish are released from acclimation sites, and the lower assumes no segregated fish are released from acclimation sites.

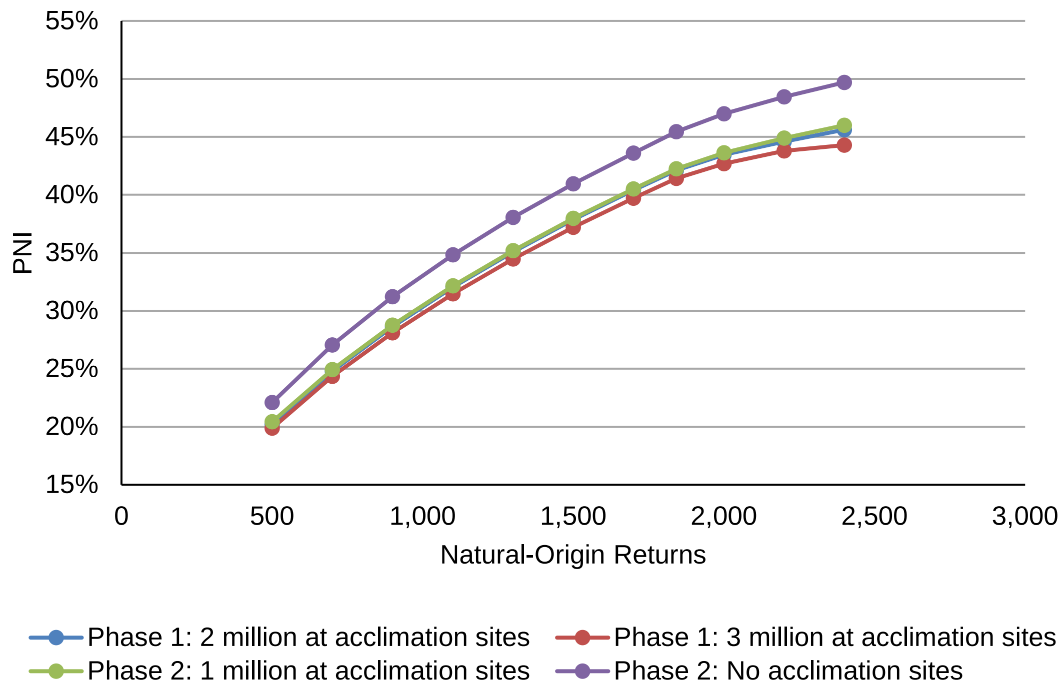


**Figure 7. The range of PNI values achievable in phases 1 and 2 with varying numbers of Chinook salmon released.**

2.5.2.2.1.3. *Green River Chinook salmon outbreeding effects*

**Within the Green River Basin**

The genetic diversity of the Green River Chinook salmon population could be adversely affected if the proposed hatchery programs incorporated as broodstock Chinook salmon originated from other Puget Sound populations. Inter-mixing the Green River stock with other Puget Sound Chinook salmon populations could decrease genetic differences between, and uniqueness of, the currently distinct, independent population in the ESU. To examine in detail the potential for gene flow from other populations into the Green River Chinook salmon population, (Haggerty 2019b) examined CWT recoveries in the Green River watershed for return years 2006 through 2015. This span of years was determined to best represent current patterns of straying that would likely occur for the Chinook salmon program operating in the basin.

Within the Green River Basin, Chinook salmon CWTs were recovered from 13 different hatchery programs including the three Green River programs. From 2006 through 2015, a total of 31,783 Chinook salmon are estimated to have spawned within the Green River salmon population's natural spawning areas (excluding Big Soos Creek). A total of 18,378 were estimated to be hatchery-origin Chinook salmon based on carcass sampling, for an estimated pHOS of 57.8%. Using CWTs as a method to expand for the number of hatchery-origin fish yields an estimate of 7,833, suggesting there is likely a large amount of error using this CWT expansion method to reconcile which hatchery fish belong to which hatchery program, because it underestimates the number of hatchery-origin fish.

There are two explanations for why the CWT method underestimates the number of hatchery fish on the spawning grounds. The first is that despite a low percentage of CWT fish from Icy Creek (13.8%; no CWTs in 4 of 12 brood years), Icy Creek CWT Chinook salmon were five times more likely to be recovered on the spawning grounds as compared to Soos Creek Hatchery fish. Second, about half (107 of 215) of all CWTs recovered on the spawning grounds were recovered in Newaukum Creek, but because there were no CWT expansion factors for Newaukum Creek (for some years), this likely underestimates the number of hatchery-origin fish spawning naturally.

Based on CWT recoveries, sampling expansion, and tag expansion, the main contributor to the pHOS level observed in the Green River Basin were from the three Green River hatchery programs (92.2%). Out-of-basin hatchery strays accounted for 7.8% of the hatchery-origin fish spawning naturally. The biggest contributors to out-basin hatchery spawners were the George Adams and Bernie Gobin (discontinued) fall Chinook salmon programs at 2.8 and 2.5% respectively. The other out-of-basin spawners each contributed less than 1%.

Similar analysis of CWTs recovered at the Green River hatchery facilities revealed that 99.8% of the fish were from the Green River hatchery programs.

**Outside the Green River Basin**

The two Chinook salmon programs could also pose risk to other Puget Sound Chinook salmon populations if fish from these programs comprise a substantial portion of the natural spawners in those populations or of the broodstock in other programs which influence those populations. We evaluated freshwater spawning ground and hatchery CWT recoveries for a total of 5.427 million CWT Chinook (brood years 2000-2011) released from the Green River Basin hatcheries (excluding Palmer Ponds). A total of 61 observed tags were recovered out-of-basin, and adjusting tag recoveries for sampling rates by recovery location resulted in 175 estimated tags in out-of-basin sites (Table 13). For context, for every 72 estimated CWTs within the basin, one tag was recovered out-of-basin, suggesting an out-of-basin stray rate of 1.3%.

When estimated tags were expanded for the number of non-CWT fish in associated releases it was estimated that at total of 1,166 hatchery fish strayed into out-of-basin areas; with 944 straying onto natural spawning areas and 222 straying to out-of-basin hatcheries. It was estimated that only 15 of the 944 fish that strayed onto the natural spawning grounds strayed to stream systems outside of the Snohomish River basin (Boise Creek, Nisqually River, and Wenatchee River). A detailed analysis of CWT recoveries in the Snoqualmie River estimated that nearly 38% of the hatchery-origin fish with a known hatchery-origin originated from Green River hatchery facilities. Within the Skykomish River population, it was estimated that 13% of the hatchery origin fish with a known hatchery-origin originated from Green River hatchery facilities.

**Table 13. Number of observed and estimated coded-wire tagged (CWT) Green River hatchery-origin fish, and estimated total number of Green River hatchery-origin fish that stray out of the Green River.**

| | Spawning Grounds | | | Hatcheries | | |
|---|---|---|---|---|---|---|
| | **Observed CWT** | **Estimated CWT** | **Expanded hatchery-origin fish** | **Observed CWT** | **Estimated CWT** | **Expanded hatchery-origin fish** |
| Total Number | 35 | 147 | 944 | 26 | 28 | 222 |
| Number in Snohomish | 32 | 135 | 508 Snoqualmie; 421 Skykomish | 11 | 11 | 119 |
| Number in other Basins | 3 | 12 | 15 | 15 | 17[1] | 103 |

[1] 8 of these were recovered in the Puyallup River Hatcheries, and the other 9 were recovered in 7 other basins.

For return years 2006 through 2015 it was estimated that unadjusted Green River hatchery-origin chinook made up 3.4%, 1.3%, and .03% of the total spawning escapement for the Snoqualmie, Skykomish, and Wenatchee Chinook salmon populations, respectively. When adjusted proportionally for hatchery-origin fish with known origin, Green River fish made up 6.9% and 3.7% of the total escapement for the Snoqualmie and Skykomish Chinook salmon populations, respectively. No Icy Creek yearlings CWTs were found in out-of-basin natural spawning areas.

To determine the amount of dispersion likely to occur into the future from Green River Chinook salmon programs, we used a tool ("recipients per year") developed during the Puget Sound dispersion analysis that includes the dispersion rate of each Puget Sound Chinook salmon hatchery program for the donor population's base period (brood years 2000 through 2011) into each of the 22 ESA-listed recipient population's (base period: return years 2006 through 2015). The tool includes a data field for annual hatchery releases for each donor population, and a population specific correction factor derived from the recipient population analysis. These two metrics along with program-to-population dispersion rates allows us to estimate future numbers of hatchery-origin fish from each program into each of the Puget Sound Chinook salmon populations.

We assumed no straying from the yearling program into the Snoqualmie and 6.8 million subyearlings with an adjusted smolt-to-adult-Snoqualmie spawner rate of 0.002412%, to estimate that on average, 164 Green River Basin hatchery-origin Chinook would stray into the Snoqualmie population. Natural-origin Chinook spawners in the Snoqualmie have averaged 1,129 (from recipient base period) and the total number of hatchery-origin spawners in the Snoqualmie is estimated to be 514 (based on currently proposed production levels), for a total average abundance of 1,643. We estimate that pHOS in the Snoqualmie River attributable to the Green River program at a release of 6.8 million subyearlings will average 10% (164/1,643).

This level of pHOS exceeds the 5% stray recommendation from Grant (1997) into the donor population. However, the authors considered all populations to be at the same tier, and did not vary the recommendation for populations at three different tiers. The Snoqualmie population is a tier 3 population under the PRA for Puget Sound Chinook, and is monitored annually for pHOS composition. Although recent data suggests that contribution from the Green River programs

into the Snoqualmie population is > 5%, this estimate does not include data from the Palmer Ponds releases, or the changes in broodstock and adult management outlined in this Opinion. We will ensure this is revisited during the 5-year review, when we will have data for a complete brood year of fish released from Palmer Ponds.

2.5.2.2.1.4. *Gene Flow Assessment for the Green River Winter Steelhead Population*

The potential negative genetic effects from the two winter steelhead programs, Soos Creek and the FRF, are considered along with the demographic benefit of increasing population abundance. To perform our analysis, we used a customized model based on Busack (2015), similar to the one used for fall Chinook salmon that uses the best available information to determine the likely PNI of the population based on the applicants' proposed pNOB and the pHOS in natural spawning areas. As previously mentioned, a PNI of > 0.5 indicates that natural selective forces outweigh hatchery-influenced selective forces, but because a recovery plan for the Puget Sound Steelhead DPS has not been finalized, the role of each population in recovery is unclear and thus we must treat all populations as primary, or tier 1. Moreover, the current draft plan (NMFS 2018c) calls for the Green River winter steelhead population to reach viability. Thus, our long-term goal for the population is a PNI of ≥ 0.67, which ensures that natural selection outweighs natural-origin selection.

Best available data suggests that, with only the Green River Native late winter steelhead program in operation, PNI has averaged about 0.86 (Table 14; based on average data from 2014-2018). This PNI is likely to continue through phase 1 because this will remain the only operational winter steelhead program To calculate the potential PNI in phase 2, which adds in the FRF winter steelhead program, and some outplanting of hatchery-origin fish into Newaukum Creek, we modeled the Green River native late winter program and the FRF program with an SAR of 0.32% (based on returns from the now terminated early winter steelhead program). We assumed an average natural-origin return of 1,200 adults (based on average data from 2014-2018), a 65% homing rate of returning adults to the FRF, and assumed that all fish that returned to the hatchery and/or the TPU trap would be removed from the system and not allowed to spawn, with the exception of 100 hatchery-origin fish into Newaukum Creek. We also assumed that the Green River native late winter program would maintain an average pNOB and number of hatchery-origin spawners similar to what they were for 2014-2018.

The additional outplanting of up to 100 hatchery-origin returns to the FRF steelhead program into Newaukum Creek did not have a great effect on PNI, but may be one way to address the decline in tributary steelhead spawners (see Figure 8), and improve the spatial structure of the population. With this approach, PNI is likely to be ≥ 0.67, and we anticipate that this will increase in the future as long as returns of natural-origin fish increase. Of note, our model accounted for a 4.2% harvest rate (both phases), but we also modeled a 15% harvest rate at the request of the co-managers (phase 2 only). We anticipate that PNI will continue to remain at or exceed a PNI of 0.67 in phases 3 and 4, once passage upstream and downstream of HHD is possible, as improved passage above HHD is likely to increase the amount of available spawning habitat.

**Table 14. Current and expected future proportionate natural influence (PNI) for the Green River natural steelhead population. Row shading denotes the difference in PNI between a 4.2% harvest rate (unshaded), and a 15% harvest rate (shaded); pHOS = proportion of hatchery-origin spawners, pNOS = proportion of natural-origin spawners, pNOB = proportion of natural-origin broodstock.**

| Time period | Average Natural-origin Returns | $pHOS_S$ | $pHOS_F$ | pNOS | $pNOB_S$ | $pNOB_F$ | PNI |
|---|---|---|---|---|---|---|---|
| Current/Phase 1 | 1200 | 0.16 | NA | 0.84 | 0.89 | NA | 0.86 |
| Phase 2 | 1200 | 0.12 | 0.20 | 0.68 | 0.88 | 0.5 | 0.67 |
| Phase 2 | 1200 | 0.12 | 0.13 | 0.75 | 0.88 | 0.5 | 0.67 |

Source: (Haggerty and Hurst 2019)

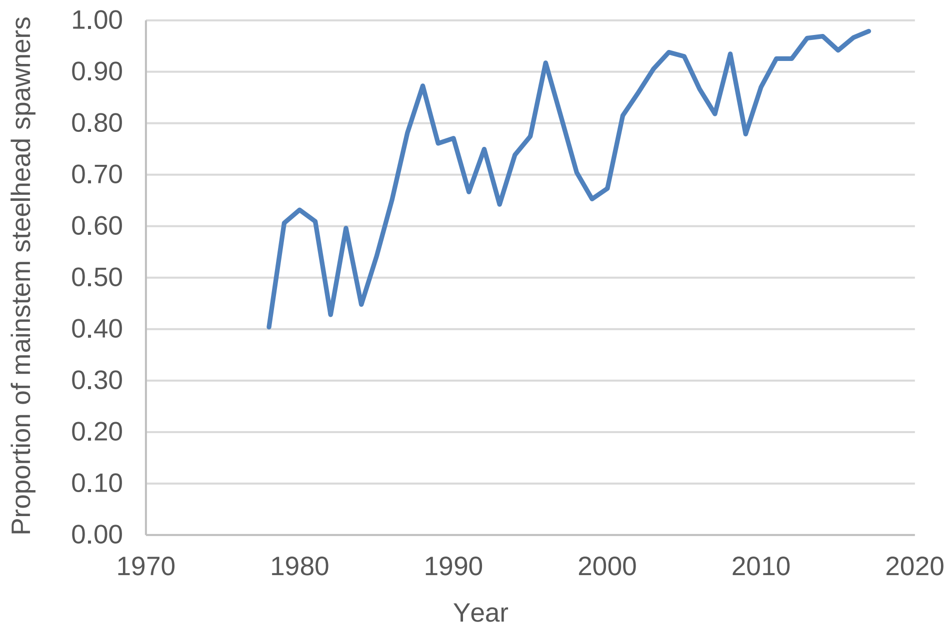


**Figure 8. The proportion of steelhead spawners in the Green River Basin that spawn in the mainstem section of the River from 1978 to 2017(WDFW et al. 2017).**

### 2.5.2.2.1.5. *Green River winter steelhead outbreeding effects from winter steelhead programs*

**Within the Green River Basin**

The genetic diversity of the Green River steelhead population could be adversely affected if the proposed winter-run steelhead hatchery programs incorporated broodstock originating from other Puget Sound steelhead populations. Inter-mixing the Green River stock with other Puget Sound steelhead populations could decrease genetic differences between, and uniqueness of, currently distinct, independent populations in the DPS.

The only potential hatchery-origin steelhead that could be mistaken for a Green River steelhead with the same marking scheme would be White River hatchery-origin steelhead. The White River steelhead population is the closest location of an independent population where straying of hatchery-origin steelhead would be likely (due to the population's proximity to the hatchery fish release sites). It is unknown if, or how many, White River hatchery-origin winter steelhead stray into the Green River each year. However, propagating and releasing only hatchery- and natural-origin fish identified by return timing, return location, and marks/tag presence/absence as part of the Green River steelhead population is likely to limit the risk of outbreeding effects resulting from returning adult hatchery-origin winter steelhead.

**Outside the Green River Basin**

The two winter steelhead programs could also pose risk to other Puget Sound steelhead populations if fish from the Green River programs comprise a substantial portion of the natural spawners in other steelhead populations or of the broodstock in programs that influence those populations. Recent (2009-2015) steelhead escapement data from the Cedar River where, on average, fewer than three natural-spawning steelhead have been observed per year, suggest few, if any, Green River hatchery-origin fish are straying into the Cedar River.

As described above, White and Green River winter steelhead programs have the same marking scheme and cannot be differentiated from one another. The risk of straying to other nearby steelhead populations appears to be very low (based on Cedar River steelhead abundance), but is unknown in the White and Puyallup Rivers. However, dispersion into watersheds where other natural-origin steelhead populations exist would be monitored and analyzed through mark and tag recovery at hatchery broodstock collection sites, and through carcass recoveries during spawning ground surveys. In addition, to reduce the risk of dispersion, juvenile hatchery fish would be acclimated to their sites of release at Soos Creek Hatchery, Icy Creek, Flaming Geyser, and the FRF (or upstream release sites) to encourage a high adult return fidelity to release location.

2.5.2.2.1.6. *Gene-flow impacts on Green River winter steelhead from the early summer steelhead (ESS) program*

Fish returning from the ESS program could have negative effects on the natural steelhead population if interbreeding occurs. Outbreeding effects are a concern whenever the hatchery- and natural-origin fish are from different populations, and this is certainly the case with the ESS and the natural population considered in this Proposed Action. The stock, having originated in the Columbia River Basin (Crawford 1979), is genetically distinct from all native Puget Sound steelhead populations (Busby et al. 1996; Phelps et al. 1997). In addition to its out-of-DPS origin, the ESS stock has been subjected to many years of intense artificial selection for early smolting, which has resulted not only in smolting predominantly at one year of age, compared to two years, or more, in natural populations, but also earlier spawning time (Crawford 1979). NMFS has previously voiced concerns about the genetic risks of ESS programs in Puget Sound (Hard et al. 2007; McMillan et al. 2010).

Evaluation of outbreeding effects is very difficult. The best existing management guidance for avoiding outbreeding effects is the conclusion of the 1995 straying workshop (Grant 1997), that

gene flow between populations (measured as immigration rates) should be under 5%. The HSRG (2009a) generally recommended that for primary populations (those of high conservation value) affected by isolated hatchery programs, the proportion of natural spawners consisting of hatchery-origin fish (pHOS) not exceed 5%, and more recently (HSRG 2014) suggested that this level should be reduced. WDFW used the Ford (2002) model to evaluate the hatchery-influenced selection risk of ESS programs, and concluded they posed less risk than integrated native-stock programs at gene flow levels below 2%, but greater risk at levels above that (Scott and Gill 2008).

Some explanation is needed at this point of the relationship between pHOS and gene flow, because the two can easily be confused. Genetic impacts from hatchery programs are caused by gene flow from hatchery fish into a naturally spawning population. Thus, if hatchery-origin fish equal natural-origin fish in reproductive success, pHOS represents the maximum proportionate contribution of hatchery-origin parents to the next generation of natural-origin fish. In the absence of other information, pHOS is an estimate of maximum gene flow on the spawning grounds. However, highly domesticated steelhead stocks are known to have low fitness in the wild (e.g., Araki et al. 2007; Chilcote et al. 1986), so gene flow is likely lower than that predicted by the Ford model. Second, the partially overlapping spawning distributions will decrease the proportion of HxN matings and increase the proportion of HxH matings relative to what it would be with total temporal overlap of spawners. Focusing attention on gene flow rates rather than pHOS is thus always advisable if feasible, and especially so in the case of ESS spawning in the wild, in which pHOS levels may considerably overestimate gene flow levels.

Gene flow is a seemingly simple concept, but developing straightforward ways to measure it is not simple. For one thing, gene flow from hatchery fish into natural populations is commonly referred to as interbreeding or hybridization. This is an oversimplification. In reality, gene flow occurs by two processes: hatchery-origin fish spawning with natural-origin fish and hatchery-origin fish spawning with each other. How well the hatchery-origin fish spawn and how well their progeny survive, determines the rate at which genes from the hatchery population are incorporated into the natural population. The importance of including the progeny of HxH matings (i.e., the progeny of two hatchery fish spawning in the wild) as a potential “vector” for gene flow is illustrated by the observation that these fish may have a considerably longer and later spawning season than hatchery-origin fish (Seamons et al. 2012). An appropriate metric for gene flow needs to measure the contributions of both types of matings to the natural population being analyzed. Another consideration is temporal scale. Although there may have been effects from gene flow from earlier more intensive and widespread hatchery activities, for the purposes of analyzing these proposed programs, what must be measured is the current rate of gene flow, which is best represented as the proportion of the current naturally produced progeny gene pool:

$Gene\ flow = (2f(HH) + f(NH))/2$ , where *f(HH)* is the proportion of naturally produced progeny produced from HxH matings, and *f(NH)* the proportion of progeny produced by NxH[6] matings

[6] As in earlier usage in this document, this is meant to represent both matings between natural-origin females and hatchery-origin males, and vice versa.

WDFW has developed two metrics for measuring gene flow in this way. The first is based on actual genetic data, and is called proportionate effective hatchery contribution (PEHC; Warheit 2014a), hereafter called the Warheit method. WDFW also has developed an alternative demographic method, hereafter called the Scott-Gill method, for calculating the expected gene flow that is based on demographic and life history data rather than genetic data (Scott and Gill 2008). Both methods and their results for the Green River Natural Steelhead population are described below.

**Estimation of gene flow using genetic data**

***Introduction to Warheit method***

Estimation of PEHC in Puget Sound steelhead is difficult because, in terms of genetic markers that are currently available, the differences between the hatchery-origin fish and natural-origin fish are slight, due to common ancestry and likely gene flow in the past. Researchers at WDFW have struggled with this problem for several years. Dr. Ken Warheit, director of the Molecular Genetics Laboratory at WDFW, in association with Dr. Shannon Knapp (formerly at WDFW, now at the University of Arizona), developed a method for estimating PEHC in situations like this (Warheit 2014a). The method is still undergoing refinement, and for that reason has received limited peer review. However, the method has been extensively reviewed by NMFS staff, and refined in response to that review.

The Warheit method involves, in part, comparing genotypes of natural-origin and hatchery-origin fish using the *Structure* program (Pritchard et al. 2000; Pritchard et al. 2010). *Structure* is one of the most widely used programs for inferring population structure, and has also been used for detecting hybrid individuals, frequently between wild and domestic populations. The WDFW Molecular Genetics Laboratory has many years' experience using the program. *Structure* makes use of each individual's multilocus genotype to infer population structure (e.g., hatchery versus wild), given an a priori assumed number of groups or populations. The program will probabilistically assign individuals to populations, or if the admixture option is used, will assign a portion of an individual's genome to populations. Through a recent detailed series of simulations, Warheit has recently determined that PEHC estimates derived from the method are upwardly biased; i.e., actual PEHC (true gene flow) will always be less than its estimate (NMFS 2019a). For more background on this method please see NMFS (2016b); NMFS (2016c).

***Application of Warheit method to the Green River Basin steelhead population***

WDFW has applied the Warheit method to the Green River natural steelhead population, as well as several other Puget Sound steelhead populations. Table 15 reports PEHC information provided in Warheit (2014b) for the Green River watershed natural steelhead population from the ESS program, along with sampling details. The table also reports projected PEHC values, which reflects the proportionate ESS program change expected[7].

[7] Projected gene flow is determined by adjusting the current or past estimate for changes that are expected under the proposed action. Simple example: if PEHC is estimated to be 1%, and the program is expected to be double, the projected PEHC would be 2%. The equation for projected values is included in WDFW (2015c).

**Table 15. PEHC estimates and confidence intervals (CI) based on past practices (2004-2013), and from the proposed ESS hatchery program for the Green River steelhead population (WDFW 2015).**

| Listed Population | Sample Size[1] | Past PEHC (%) and 90% CI | Projected PEHC (%) under Proposed HGMPs |
|---|---|---|---|
| Green River Winter | 165 | 1.0; 1.0-2.0 | 2.0 |

[1]From juveniles and adults sampled in 2004, 2007, 2008, and 2013.

PEHC estimates are likely overestimates of gene flow. The Warheit method is intended to estimate current gene flow, but it is inevitable that some mixed lineage fish that are not the immediate result of HxH or HxN matings will be identified as such (Warheit 2014a), inflating the PEHC estimate. The degree to which these misidentifications inflate PEHC has not been explored, and the effect on confidence intervals is unknown, but the effect will increase with increasing gene flow. These issues all need to be clarified in further development and updating of the method. However, assuming that PEHC has not been systemically underestimated in some way due to a bias in the estimation process, and considering the confidence intervals, recent gene flow from the ESS program into this basin appears to have been about 1%. The expectation is that PEHC will remain at less than 2% based on a four year average (one steelhead generation) in recognition of annual variability. A monitoring plan specific for the Green River to verify the PEHC estimate will be developed by the co-managers and submitted to NMFS within four months of Opinion signature.

**Estimation of gene flow using demographic methods**

***Scott-Gill Method***

Direct measurement of gene flow is preferred over estimation of gene flow based on demographic parameters, but WDFW has developed a demographic approach called the Scott-Gill method (WDFW 2008). The method assumes that the spatial and temporal distribution overlap of spawning of hatchery-origin and natural-origin fish can be divided into three regions: A, where only HxH matings are possible; B, where HxH, HxN, and NxN are possible; and C, where only NxN matings occur.

The Scott-Gill method assumes random mating within mating region, and uses estimates of the proportion of spawners that are of hatchery origin (pHOS[8]), the proportion of hatchery-origin and natural-origin spawners in region B, and the relative reproductive success (RRS) of the HxH and NxH mating types to compute the proportion of the offspring gene pool produced by hatchery-origin fish. Although the value produced by the equation appears to be analytically identical to PEHC, we will call it DGF (demographic gene flow) to prevent confusion as to which metric we are discussing, and to distinguish the metric from the concept. Please see Hoffmann (2014) for more information on this method for calculating gene flow.

[8] Symbolized by q in the equation in WDFW documents.

Table 16 presents the NMFS-derived DGF values for the Green River steelhead natural population computed with the same assumed values about RRS (0.09 to 0.18 for HxH ESS matings and 0.60 for ESS HxN), and pHOS as proportion of hatchery-origin escapement (30%), as was done for Hoffmann (2014) case 6b in the Skykomish River basin (NMFS 2016c). This assumption of 30% of the hatchery-origin escapement remaining in the river to spawn was considered to be conservative (i.e., greater or higher) in comparison to earlier estimates by the HSRG of 10-20%. PEHC estimates were based on whatever samples were available and deemed appropriate, rather than data collected on a regular schedule over the years. The years of demographic data used for DGF estimates were selected by NMFS from those available to best represent existing demographic variation (i.e., most recent 5-years).

The Scott-Gill results indicate that gene flow has been about 2% in the Green River steelhead natural population and it is likely to remain the same or slightly increase to approximately 2.2% under the proposed action. However, there is uncertainty around this conclusion because of the assumed stray rates and RRS values that require validation. Whatever error exists in the DGF estimate is predominantly due to parameter uncertainty, rather than error associated with assumed statistical distributions, so no confidence intervals are included with the estimates in Table 16. We did not complete a comprehensive sensitivity analysis, but did discuss our concerns previously in (NMFS 2016b); NMFS (2016c).

**Table 16. DGF values generated from the Scott-Gill equation for the Green River winter steelhead natural population. For recent past pHOS and DGF, means are reported with maxima in parentheses and assume a 30% stray rate and 0.18 RRS value. Projected DGF values are based on an assumed 30% stray rates and a 0.18 RRS value.**

| Parameter | Values (%) |
|---|---|
| Escapement years | 2014-2018 |
| $O_N$ | 1.28 |
| $O_H$ | 27.9 |
| Recent past pHOS | 4.4 (10.3) |
| Recent past DGF | 1.1 (2.4) |
| Projected pHOS | 9.1 |
| Projected DGF | 2.1 |

**Summary**

Both metrics indicate that gene flow into the Green River natural steelhead population from the ESS program is likely to be approximately 2.0%, a value previously determined by NMFS to be acceptable in the similar early winter programs in Puget Sound (e.g., NMFS 2016b). The co-managers have committed to the annual gathering and analysis of data, and will also be required to implement the terms and conditions of the ITS (Section 2.9). Thus, NMFS concludes that gene flow from the proposed action is approximately 2% into the Green River natural steelhead population, and any negative effect is likely to decrease as the co-managers transition to a Puget Sound summer steelhead stock with the intent of minimizing genetic effects of any naturally spawning summer steelhead.

#### 2.5.2.2.2. Ecological Effects

##### 2.5.2.2.2.1. *Adult nutrient contribution*

The return of hatchery fish likely contributes nutrients to the action area. Decaying carcasses of spawned adult hatchery-origin fish would contribute nutrients that increase productivity in the Green River Basin, providing food resources for naturally produced Chinook salmon and steelhead. Diminished numbers of salmonids returning to spawn in most Puget Sound watersheds have resulted in nutrient deficiencies compared to historical conditions, affecting salmon and steelhead productivity potential. Adult salmon and steelhead spawning escapements have substantially declined to a fraction of their historical abundance in many watersheds, raising concerns about a lack of marine-derived nutrients returning back to the systems in the form of salmon carcasses. Historically, salmonids themselves were an important source of nutrients to both riverine and riparian ecosystems (WRIA 2000).

Estimates of naturally spawning hatchery-origin salmon and steelhead are depicted in Table 17. It was estimated that these naturally spawning hatchery-origin salmon and steelhead would contribute 232.7 kg of phosphorous to the action area annually during phase 1. We also assumed that all returning steelhead would die after spawning, but there is likely some portion of the steelhead spawners that leave the system as kelts, and return to spawn again in subsequent years. Excluded from this table are the coho released from the Des Moines and Elliott Bay net pens because data suggests that about 96% are harvested in pre-terminal fisheries (average from 2009-2013; Schaffler 2018). Marine Technology Center coho releases are also not included below, as these fish do not return to the Green River watershed. In phase 2, the nutrient concentration increases to 240.3 kg, because of the additional release of Chinook and coho salmon, and steelhead at the FRF. This contribution is likely to be similar in phases 3 and 4 as no additional fish releases are proposed.

The transport by anadromous fish of nutrients from the marine environment to freshwater is important because temperate freshwater environments like that of the action area are typically low in available nutrients and relatively unproductive (Cederholm et al. 2000). Thus, hatchery-origin fish increase phosphorous concentrations, which likely compensates for some marine-derived nutrients lost from declining numbers of natural-origin fish.

**Table 17. Total phosphorous imported by adult returns from the proposed hatchery programs based on the equation (Imports= hatchery adults*mass*phosphorous concentration) in Scheuerell et al. (2005). Italicized rows are those programs that are only included in phase 2. NA = not applicable; FRF = Fish Restoration Facility; KCC = Keta Creek Complex; SCH = Soos Creek Hatchery; SAE = smolt to adult escapement.**

| Program | Species | Release Size | SAE (%) | Percentage on natural spawning grounds | Percent Removed | Hatchery Spawners | Adult Weight (Kg) | Phosphorous Concentration | Phosphorous Imported Kg/Y |
|---|---|---|---|---|---|---|---|---|---|
| SCH | Chinook | 3,520,000 | 0.338 | 11.3 | 20 | 1078 | 5.5 | 0.0038 | 22.5 |
| Icy Creek | Chinook | 330,000 | 0.295 | 55.4 | 20 | 432 | 5.5 | 0.0038 | 9.0 |
| Palmer Ponds | Chinook | 3,300,000 | 0.338 | 86.4 | 20 | 7709 | 5.5 | 0.0038 | 161.1 |
| *FRF* | *Chinook* | *660,000* | *0.338* | *11.3* | *20* | *202* | *5.5* | *0.0038* | *4.2* |
| | | | | | | | | | |
| SCH | Coho | 660,000 | 2.065 | 1.6 | 0 | 215 | 2.7 | 0.0038 | 2.2 |
| KCC | Coho | 1,100,000 | 3.498 | 1.6 | 0 | 608 | 2.4 | 0.0038 | 5.5 |
| KCC Off Station | Coho | 55,000 | 3.498 | 1.6 | 0 | 30 | 2.4 | 0.0038 | 0.3 |
| *FRF* | *Coho* | *660,000* | *2.065* | *1.6* | *0* | *215* | *2.7* | *0.0038* | *2.2* |
| | | | | | | | | | |
| KCC | Chum | 5,500,000 | 0.343 | 10 | 0 | 1886 | 4.3 | 0.0038 | 30.8 |
| | | | | | | | | | |
| *FRF Native* | *Steelhead* | *275,000* | *0.307* | *35* | *0* | *295* | *3.6* | *0.0038* | *1.2* |
| Green River Native | Steelhead | 60,500 | 0.307 | 100 | 0 | 179 | 3.6 | 0.0038 | 0.7 |
| Green River Summer | Steelhead | 110,000 | 0.491 | 30 | 0 | 162 | 3.2 | 0.0038 | 0.6 |
| Total (phase 1) | | | | | | | | | 232.7 |
| Total (phase 2) | | | | | | | | | 240.3 |

Sources: fall Chinook parameters were from Haggerty 2018(Haggerty 2018); coho salmon SAE to hatchery survival from CWT recoveries in RY 2009 through 2015 (RMIS query), coho escapement and pHOS from WDFW (WDFW coho escapement workbook, 2019); fall chum SAEs from WDFW's 2019 chum salmon forecast, assumed 10% stray rate; winter steelhead parameters were calculated in (Haggerty 2018), assumes FRF pHOB removed from mainstem, and 30% in-river post spawning mortality; and summer steelhead parameters from demographic gene flow calculations.

#### 2.5.2.2.2.2. *Spawning ground competition and redd superimposition*

**Chinook Salmon**

Hatchery-origin adult salmon and steelhead produced through the within-basin hatchery salmon and steelhead programs that escape to spawn naturally have the potential to adversely affect listed Chinook salmon through competition for spawning sites and redd superimposition. For the Green River population, natural-origin returns have averaged less than 2,000 fish, and Chinook returns from the proposed programs, after accounting for harvest and hatchery rack returns are estimated to be about 9,600 fish (Table 17). The current spawning stock size at equilibrium is 4,423. Thus, it is likely that, during most years, the watershed is under-seeded with naturally spawning Chinook salmon, making competition for spawning sites with and redd superimposition by hatchery Chinook salmon unlikely to occur.

Coho salmon produced through the Marine Technology Center Coho Hatchery Program, components of the Soos Creek Coho Hatchery Program (TU Miller Creek Hatchery Co-Op, Des Moines Net Pen, and Miller Creek egg transfers), and half of the coho salmon smolts produced by the Keta Creek Complex Yearling Coho Hatchery Program, are released outside of the Green River Basin. Of those released within the basin during phase 1, an estimated 854 are expected to escape to spawn naturally. We assume that, once the FRF comes online, harvest rates and hatchery rack returns for coho originating from the FRF program will be similar to the other programs within the basin. Thus, the program is estimated to result in an additional 2,015 fish to the spawning grounds during phase 2.

It is important to note that coho and Chinook have always existed in the watershed together. Furthermore, based on spawn timing and spawning habitat preference differences between coho and Chinook salmon, effects of competition for spawning sites and/or redd superimposition are expected to be low as a result of coho salmon production in the action area across all four phases. When coho return, water availability is greater, which allows coho to migrate further upstream in the tributaries. The few coho salmon that spawn in the mainstem or side channels tend to spawn in areas that had been too shallow for Chinook salmon (Eric Warner, MIT, personal communication, November 5, 2018). NMFS anticipates that the number of hatchery-origin fish on the spawning grounds will not increase by more than 50% of the number in Table 17 (i.e., 535 spawners) based on a 5-year running average beginning in 2019 (average of 2015-2019).

Hatchery-origin chum salmon spawn in the areas used by Chinook salmon. However, competition for spawning sites and redd superimposition are unlikely to occur for a number of reasons. First, Chinook salmon redds are usually constructed in reaches with larger substrate size (Kondolf and Wolman 1993), deeper water, faster water velocities, and deeper egg pockets than those constructed by chum salmon (DeVries 1997; Geist et al. 2002; Quinn 2005). Second, most Chinook salmon spawning in the Green River is complete before the onset of chum salmon spawning (Table 18). Third, habitat availability during chum salmon spawning differs from when Chinook salmon spawned due to higher water levels associated with later spawn timing (Geist et al. 2011; Eric Warner, MIT, personal communication, March 21, 2019). Fourth, a study by Burns et al. (2018) found that chum salmon also spawned in upwelling water that was significantly warmer than the surrounding river water. In contrast, fall chinook salmon constructed redds at

downwelling sites, where there was no difference in temperature between the river and its bed. Finally, the spawning distribution for chum is weighted lower in the watershed than for Chinook. Only a third of chum make it as far upstream as the mouth of Crisp Creek (< 3% at Flaming Geyser Park), and it is unclear if these chum salmon spawn successfully. A substantial portion spawns below Soos Creek. By comparison, Chinook salmon spawn from the mouth of Soos Creek upstream to the Headworks dam (Eric Warner, MIT, personal communication, March 21, 2019). For the reasons detailed above, spawning site competition and redd superimposition between Chinook salmon and hatchery chum salmon is unlikely to occur.

Hatchery-origin winter steelhead return at low relative abundances compared to Chinook salmon within the Green River Basin. In addition, Chinook salmon spawning peaks in mid-October, whereas winter steelhead spawning peaks in mid-April (Table 18), and there is no temporal overlap between the two spawning aggregations (WDFW spawning ground survey database). Therefore, there is no competition for spawning sites between the two species. Redd superimposition is not possible since Chinook salmon eggs will have hatched prior to the onset of hatchery winter steelhead spawning.

Summer hatchery-origin steelhead within the Green River Basin have a spawn timing that starts and peaks in January but extends through mid-March. Based on spawning habitat preference and spawn timing, there are unlikely to be any spawning habitat competition effects on Chinook salmon from hatchery summer steelhead.

**Steelhead**

Adult salmon produced by the hatchery programs that escape to spawn naturally do not have the potential to adversely affect listed steelhead through competition for spawning sites and redd superimposition. Green River Chinook salmon spawn from mid-September through early-November (Table 18), well before the earliest spawning winter steelhead enter the river as returning adults. Coho salmon spawn from late-October through mid-January, also well before the earliest-timed winter steelhead. Chum salmon have spawn timing similar to that of coho, from mid-November through December. Thus, there are unlikely to be any competition and redd superimposition effects of hatchery salmon on winter steelhead due to temporal separation.

The primary intent of the two hatchery winter steelhead programs is to produce native stock adult fish for conservation purposes, with a goal of using hatchery-origin fish to seed the mainstem and tributaries to meet an escapement goal of 2,003 fish, which was only met in one of the last five years (WDFW Score). This is well below the intrinsic potential estimates of 20,000-40,000 for the population (Myers et al. 2015). Thus, the watershed is likely under-seeded with naturally spawning steelhead, making competition and redd superimposition from the steelhead programs unlikely to occur as space is not limiting.

ESS straying into natural spawning areas are likely to occupy the same or similar habitat used by natural-origin winter steelhead. Hoffmann (2014) estimated that only ~1% of all natural-origin winter steelhead spawning occurred prior to March 15, suggesting that temporal overlap between ESS and winter steelhead is very small. It is anticipated that a majority of the total annual ESS adult returns will be removed through harvest and escapement to the hatcheries, decreasing the number of hatchery fish available for straying (estimated to average 90-150 per year (assuming

20% to 30% stray rates) into natural steelhead spawning areas (Hard et al. 2007; WDFW 2015). Thus the temporal separation between ESS and natural steelhead spawners, and the likely low number of steelhead remaining in the rivers after harvest and hatchery escapement, decreases the likelihood of competition for spawning sites and makes redd superimposition unlikely.

**Table 18. Terminal area/river entry timing, spawn timing, and spawning location for Green River Basin Chinook, chum, and coho salmon, and steelhead populations.**

| Species | Terminal Area/River Entry Timing | Spawn Timing | Spawning Locations |
|---|---|---|---|
| Chinook salmon | Late-July to September | September 15 to early-November | Mainstem Green River and Newaukum and Big Soos Creeks |
| Chum salmon | November to early-December | Mid-November to December | Mainstem Green River, side channels, various tributaries |
| Coho salmon | September to early-November | Late-October to mid-January | Green River and various tributaries |
| Winter steelhead | November to April | March to May | Mainstem Green River and Newaukum and Big Soos Creeks |
| Summer steelhead | June to early-October | Late-December to March | Green River and various tributaries |

Sources: (WDFW spawning ground database;Tribe and USFWS 1977; WDFW and WWTIT 1994)

#### 2.5.2.2.3. Disease

Adults returning back to hatchery facilities can have pathogens they become infected with upon their return to freshwater or that may have contracted during their juvenile rearing and outmigration. For programs in the Green River, *Flavobacterium psychrophilum*, *Aeromonas salmonicida*, *Nanophyetes salmincola*, *Ichthyopthirius multifiliis*, *Saprolegnia sp.*, and *Henneguya salmincola* were all detected. These pathogens are all native to the Green River Subbasin and did not result in any disease outbreaks in adults over the most recent three years of data. Adults are also routinely screened for viral pathogens, such as infectious hematopoietic necrosis virus (IHNV) and infectious pancreatic necrosis virus (IPNV), but none were detected over the last three years. Based on the endemic state of the pathogens and the lack of outbreaks, risk of disease transmission and amplification from returning adults is low.

#### 2.5.2.2.4. Adult Collection Facilities

The operation of weirs and traps for broodstock collection may result in the capture and handling of both natural- and hatchery-origin Chinook salmon and steelhead (Table 19). Samples for genetic analyses may also be taken from all steelhead regardless of origin at the time of collection. The proposed handling numbers are higher than the most recent five years would suggest are needed to account for increases in both the currently operated Chinook (2 million subyearlings) and steelhead programs (22,000 smolts) in phase 1, and for the addition of the FRF steelhead program in phase 2 (250,000 smolts). Alternative methods may be needed to capture broodstock because of the unknowns associated with the mechanics of the Soos Creek Hatchery rebuild, including how adults will respond to the new fish ladder, weir, and adult ponds in the range of low to high water conditions. These methods could involve seining or netting the area

below the new fish ladder entrance down to the bridge at the lower end of the hatchery property, and/or in-river collections at various access points on the Green River to collect natural-origin fish. In addition, the TPU trap is likely to be operated for a longer period of time, resulting in an increase in handling at that site compared to previous years. Handling of listed species in phases 3 and 4 is likely to be similar for hatchery fish, but may increase for natural-origin fish if returns improve.

**Table 19. Number of ESA-listed Chinook salmon and steelhead handled by origin for all program facilities. Maximum incidental mortalities in any given year, if any, are shown in parentheses and exclude those collected and held for broodstock.**

| Facility | Origin | Chinook Salmon | | Steelhead | |
|---|---|---|---|---|---|
| | | Average; range (mortalities) | Proposed (mortality) | Average; range (mortalities) | Proposed (mortality) |
| Soos Creek Hatchery Weir | Natural | 688; 163-1497[1] | 2,000 (40)[2] | 1 (0) | 10 (1) |
| | Hatchery | 10670; 3964-17454[1] | 25,000 (500)[3] | 0 | 10 (1) |
| Icy Creek Weir | Natural | 4 handled (4)[1] | 10 (1) | 0 | 5 (0) |
| | Hatchery | 0-202 (0) | 10 (0) | 0 | 200 (0) |
| Keta Creek Complex Weir | Natural | 52; 5-199 (5) | 250 (25) | 0 | 5 (5) |
| | Hatchery | 120; 12-465 (10) | 750 (150) | 0 | 10 (5) |
| Fish Restoration Facility | Natural | 0 | 2,000 (50) | 0 | 400 (20) |
| | Hatchery | 0 | 8,000 (240) | 0 | 400 (40) |
| Miller Creek Hatchery | Natural | 0 | 5 (0) | 0 | 2 (0) |
| | Hatchery | 0 | 5 (0) | 0 | 5 (0) |
| TPU Trap | Natural | 107; 0-498 (1) | 1,000 (10) | 5; 0-12 (1) | 400 (20) |
| | Hatchery | 206; 0-696 (3) | 8,000 (40) | 13; 4-34 (0) | 400 (40) |
| Marine Technology Center | Natural | 0 | 5 (0) | 0 | 2 (0) |
| | Hatchery | 0 | 5 (0) | 0 | 5 (0) |

Sources: (Coccoli 2018b; WDFW 2018b)

[1] The configuration of Soos Creek Hatchery is such that fish cannot move upstream of the hatchery unless they first go through the hatchery. Thus, there is no handling of fish without some period of holding, and this mortality is already captured in the collection and holding values in Table 2.

[2] These values also account for the handling effects of alternative broodstocking methods such as seining and netting at various access points on the Green River to collect natural-origin fish.

[3] The hatchery handling number was based on the increase in production from 4.5 to 6.5 million, and the best survival rate observed in recent years. We expect up to 2% incidental mortality may occur in the future with the redesigned weir and adult holding ponds.

Other effects of weir operation are the potential for delayed migration and changes in spatial distribution of listed species. Though adult passage may be delayed slightly, weir operation guidelines and monitoring of weirs by the co-managers minimize the delays to and impacts on fish; fish generally are not delayed for more than 24 hours throughout the trapping season. In addition, the spatial distribution of juvenile and adult listed species is not expected to be affected by weir operation in these areas because the weirs are designed to allow juvenile passage, and natural-origin adults are passed upstream when not required for broodstock.

### 2.5.2.3. Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, migratory corridor, estuary and ocean

The effects of this factor on both listed species are negative, as discussed in greater detail below.

#### 2.5.2.3.1. Competition and predation in rearing areas and the migratory corridor

Competition may result from direct or indirect interactions between listed natural-origin salmonids and hatchery fish released as part of the proposed action. Direct interactions occur when hatchery-origin fish interfere with accessibility to limited resources by natural-origin fish. For example, hatchery fish may take up residency before naturally produced fry emerge from redds. Indirect interactions occur when the utilization of a limited resource by hatchery fish reduces the amount available for fish from the natural population (Rensel et al. 1984), such as food and rearing sites (NMFS 2012).

Several factors influence the risk of competition posed by hatchery releases: whether competition is intra- or interspecific; the duration of freshwater co-occurrence of hatchery and natural-origin fish; relative body sizes of the two groups; prior residence of shared habitat; environmentally induced developmental differences; and density in shared habitat (Tatara and Berejikian 2012). Intraspecific competition would be expected to be greater than interspecific, and competition would be expected to increase with prolonged freshwater co-occurrence. Hatchery smolts are commonly larger than natural-origin fish, and larger fish usually are superior competitors. However, natural-origin fish have the competitive advantage of prior residence when defending territories and resources in shared natural freshwater habitat. Tatara and Berejikian (2012) further reported that hatchery-influenced developmental differences from co-occurring natural-origin fish are variable and can favor both hatchery- and natural-origin fish. They concluded that of all factors, fish density of the composite population in relation to habitat carrying capacity likely exerts the greatest influence.

Another important possible ecological effect of hatchery releases is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead. Predation, either direct (direct consumption) or indirect (increases in predation by other predator species due to enhanced attraction), can result from hatchery fish released into the wild. In general, the threat from predation is greatest when natural populations of salmon and steelhead are at low abundance, when spatial structure is already reduced, when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility. Our analysis below can only consider the effects of direct predation. Although we acknowledge the possibility of indirect predation, we have no way to assess the effect at this time.

##### 2.5.2.3.1.1. *PCD Risk Model Analysis in Freshwater*

While competition and predation are important factors to consider, they are events which can rarely if ever be observed and directly calculated. However, these behaviors have been established to the point where NMFS can model these potential effects to the species based on known factors that lead to competition or predation occurring. Here, we used the PCD Risk model version 3.1 of Pearsons and Busack (2012), to quantify the potential number of natural-origin Chinook salmon and steelhead juveniles lost to competition and predation from the release

of hatchery-origin juveniles. Although model logic is still largely as described in the 2012, the PCD Risk model has undergone considerable modification since then to increase supportability and reliability. Notably, the current version no longer operates in a Windows environment and no longer has a probabilistic mode. We also further refined the model by allowing for multiple hatchery release groups of the same species to be included in a single run. The one modification to the logic was a 2018 elimination of competition equivalents and replacement of the disease function with a delayed mortality parameter. The rationale behind this change was to make the model more realistic; competition rarely directly results in death in the model because it takes many competitive interactions to suffer enough weight loss to kill a fish. Weight loss is how adverse competitive interactions are captured in the model. However, fish that are competed with and suffer some degree of weight loss are likely more vulnerable to mortality from other factors such as disease. Now, at the end of each run, the competitive impacts for each fish are assessed, and the fish has a probability of delayed mortality based on the competitive impacts. This function will be subject to refinement based on research. For now, the probability of delayed mortality is equal to the proportion of a fish's weight loss. For example, if a fish has lost 10% of its body weight due to competition and a 50% weight loss kills a fish, then it has a 20% probability of delayed death, (0.2 = 0.1/0.5).

For our model runs, we made a number of assumptions for some of the parameter inputs, consistent with all of the other consultations in which we use this model (Table 20). We assumed a 100% population overlap between hatchery fish and ESA-listed natural-origin Chinook salmon and steelhead present. We acknowledge that a 100% population overlap in microhabitats is likely an overestimation. We also assumed that habitat complexity was low at only 10% to account for habitat degradation in the Green River Basin. We used habitat segregation estimates of 0.3 for conspecifics, and 0.6 for other species, a dominance mode of 3 and maximum encounters per day of 3, based on what was decided in the HETT (2014) database for hatchery programs of the same life stage and species.

**Table 20. Parameters in the PCD Risk model that are the same across all programs.**

| Parameter | Value |
|---|---|
| Habitat complexity | 0.1 |
| Population overlap | 1.0 |
| Habitat segregation | 0.3 for conspecifics, 0.6 for all other species |
| Dominance mode | 3 |
| Maximum encounters per day | 3 |
| Predator:prey length ratio for predation | 0.25[1] |

[1] Daly et al. (2014)

In contrast to some previous consultations where we ran the model using numbers of natural-origin fish that allowed the hatchery-origin fish to exhaust all interaction possibilities at the end of each day, in this case, we had data to inform the actual number and proportion of natural-origin juveniles of each species present in the Green River Basin (Table 21). For Chinook salmon, this was based on average data from the annual smolt trapping estimates that occurred in the watershed from 2012 to 2016 (Topping and Anderson 2017). For steelhead, we back calculated steelhead smolts from the total adult steelhead spawners in the basin from 2014 to 2018 using a smolt to adult survival rate of 1.5%. We then assumed survival of fry-age-1 smolts of 15% and survival of fry-age-2 smolts of 10% based on (Quinn 2005). We then calculated the number of parr by diving the age-2 smolt value by an assumed 50% survival rate from parr to age-2 smolt. To calculate the number of fry we then divided age-1and age-2 smolts by the aforementioned fry-smolt survival rate. Summing all of the life stage numbers together, we were then able to determine the proportion of each lifestage. For more detail, please see Hurst and Haggerty (2019). We believe this more closely mimics the reality of the Green River system compared to how we have modeled abundance and proportions of natural-origin fish in previous consultations.

We also were able to rule out encounters with natural-origin Chinook salmon and steelhead from the model for some hatchery species. This is because Chinook salmon fry typically have their peak emigration in February (see Section 2.2.1.1), well before most hatchery species are released. Thus, Chinook salmon fry were only included in the model for hatchery chum salmon. Similarly, most hatchery fish releases occur well before steelhead emergence. Thus, we used steelhead redd data to extrapolate fry emergence based on emergence requiring ~1200 accumulated temperature units (ATUs; Haggerty 2019a). This ATU value was suggested by Coccoli (2018a) based on work from Burton (2003). Using this information, and considering the hatchery fish release windows, we were able to include only the proportion of steelhead fry that would have emerged assuming that hatchery fish are all released on the last day of their release window and assuming that all hatchery fish take the full length of travel time to the mouth of the Green River. For example, hatchery coho released on May 15th from the FRF site would take an estimated 22 days to travel to the river mouth (Table 22). This would mean that they would not exit the system until June 6th.

**Table 21. Age, size, and occurrence of listed natural-origin salmon and steelhead encountered by juvenile hatchery fish after release.**

| Species | Abundance | Lifestage | Size in mm (SD) | Lifestage Proportion | Occurrence |
|---|---|---|---|---|---|
| Chinook salmon | 451,692 | fry | 41 (4) | 0.66 | Late-January – early-April |
| | | parr | 69 (16) | 0.34 | Mid-April - June |
| Steelhead | 943,575 | fry | 60 (19) | 0.8 | June - October |
| | | parr | 96 (17) | 0.1 | October - mid-May |
| | | smolt | 170 (23) | 0.1 | April - May |

Sources: (Beamer et al. 2005; Shapovalov and Taft 1954; Topping and Anderson 2017)

For the hatchery-origin juveniles releases, a number of release groups are not anticipated to have effects on ESA-listed natural-origin Chinook salmon and steelhead because of their release location. The Marine Technology Center coho are released into "North Creek," and the Soos Creek coho that are released into Miller, Walker, and Des Moines Creeks are released into streams that are tributary to Puget Sound, and are not known to contain listed fish. Thus, they were excluded from our analysis of predation and competition in freshwater. We assumed 100% survival for all hatchery fish from release until the mouth of the Green River; this is likely an overestimate due to habitat conditions in the Green River, and could be modified with additional data.

**Table 22. Hatchery fish parameter values and release information for the PCD Risk model; SCH = Soos Creek Hatchery, IC = Icy Creek Rearing Ponds, FGP = Flaming Geyser Ponds, KCC = Keta Creek Complex, FRF = Fish Restoration Facility; CV = coefficient of variation. Fish released only in phase 1 are bolded; fish released only in phase 2 are italicized.**

| Program | Release number[1] | Release size (mm) | Release size CV | Release timing | Release temperature (°C) | Release location | Piscivory rate | Travel rate (miles/day)[3] | Travel time to river mouth (days) |
|---|---|---|---|---|---|---|---|---|---|
| SCH Fall Chinook | 3,520,000 | 80 | 0.08 | Early-May-June | 12.7 | SCH | 0.002 | 3.5 | 10 |
| | **3,300,000** | 106 | 0.10 | June-July 4 | 14.4 | Palmer Ponds | 0.002 | 3.5 | 16 |
| | 330,000 | 181 | 0.10 | April | 8.3 | IC | 0.002 | 9.6 | 5 |
| FRF Fall Chinook | *3,960,000* | 94 | 0.10 | June | 12.7 | FRF | 0.002 | 3.5 | 17 |
| FRF Coho | *660,000* | 150 | 0.10 | April-May15 | 9.8 | FRF | 0.0189 | 2.7 | 22 |
| KCC Coho | 1,100,000 | 150 | 0.10 | April-May10 | 9.8 | KCC | 0.0189 | 2.7 | 15 |
| | 55,000 | 150 | 0.10 | April-May15 | 9.8 | FRF site | 0.0189 | 2.7 | 22 |
| SCH Coho | 660,000 | 140 | 0.07 | April-May10 | 9.8 | SCH | 0.0189 | 2.7 | 13 |
| KCC Fall Chum | 5,500,000 | 54 | 0.10 | March-May15 | 10.4 | KCC | 0.0000 | 5.4 | 8 |
| FRF steelhead | *275,000* | 193 | 0.10 | mid-April-June 30 | 10.8 | FRF | 0.0023 | 4.7 | 13 |
| Green River Native Winter Steelhead | 25,300 | 193 | 0.10 | May | 10.3 | IC | 0.0023 | 4.7 | 10 |
| | 16,500 | 193 | 0.10 | May | 10.3 | FGP | 0.0023 | 4.7 | 9 |
| | 18,700 | 193 | 0.10 | May | 10.3 | Palmer Ponds | 0.0023 | 4.7 | 12 |
| Green River Summer Steelhead[2] | 110,000 | 211 | 0.08 | mid-April-May | 10.3 | IC | 0.0023 | 4.7 | 10 |

Source: (Hurst and Haggerty 2019)

[1] Our analysis includes an extra 10% added to the proposed production goal to account for variability in release numbers.

[2] We assumed release of all fish from this program at the site furthest upstream in the event that co-managers decide to release all fish at that location.

[3] The Chinook subyearling rate was based on data from the Puyallup/White River, other travel rate estimates were based upon the WDFW smolt trap data collected on the mainstem Green River at RM 34.5 (Topping and Anderson 2017).

Similar to the use of models for biological systems elsewhere, this model cannot possibly account for all the variables that could influence competition and predation of hatchery juveniles on natural juveniles. For example, the model assumes that if a hatchery fish is piscivorous and stomach capacity allows the fish to consume prey it will be natural-origin prey. The reality is hatchery-origin fish could choose to eat a wide variety of invertebrates, other fish species (e.g., shad, minnows), and other hatchery-origin fish in addition to natural-origin smolts. However, we believe that with this model we are estimating, to the best of our ability, a worst-case estimate for the effects on natural-origin juveniles.

Based on the parameter inputs above, our model results show that the release of hatchery juveniles are likely to have the largest effect on natural-origin steelhead, followed by Chinook salmon. The maximum numbers of juvenile fish lost for each species are shown in Table 23. When we convert these to adult equivalents, 52 Chinook salmon adults and 44 steelhead adults would be lost in phase 1. These numbers increased to 73 and 62 respectively for Chinook salmon and steelhead for phase 2, with the addition of the three FRF programs. Using the average number of natural-origin returns for Chinook salmon from 2013-2017 of 1842, this loss would equate to about a maximum potential loss of ~ 2.8% of the potential adult return for Chinook salmon. Using the average number of natural-origin returns for steelhead from 2014-2018 of 1200, this loss would equate to about a maximum potential loss of ~ 3.7% of the potential adult return for steelhead during phase 1. These percentages would increase to 4.0 and 5.2% for Chinook salmon and steelhead respectively in phase 2.

Travel time[9] of juvenile hatchery fish can have a substantial ecological effect. This is because the slower fish travel, the more time available for preying and competing on the natural-origin juveniles in the area. Thus, NMFS recommends the applicants monitor the average number of days required for each release to migrate to the mouth of the River as compared to the values in Table 22. If the value increases by more than 5 days over the course of a 5-year running average, this could increase the potential for ecological effects[10].

[9] Travel rates were calculated by assuming 12 hours for day 1, and 24 hours for each proceeding day, fish were summed over the entire emigration period and day where 50% of fish were trapped at the Green River screw trap was then determined. Typically this included additional fish for which a fractional day was calculated. For example, 5200 marked fish represented 50% of the fish captured. Assume a cumulative catch on day 4 of 5000, and on day 5 a cumulative catch of 5500, then day 5 would be (5200-5000)/(5500-5000)=0.4 days, day 2-4=3 days, and day 1=0.5 days, for a total time period 4.1 days. Then travel rate is simply distance/time.

[10] NMFS recognizes that this metric can be influenced by factors other than hatchery operation (i.e., environmental variables, hydrosystem operation).

**Table 23. Maximum numbers and percent of juvenile natural-origin salmon and steelhead lost annually to competition and predation with hatchery-origin fish released from the Proposed Action.**

| Phase | Hatchery Species | Chinook | | Steelhead | |
|---|---|---|---|---|---|
| | | Predation | Delayed Mortality | Predation | Delayed Mortality |
| 1 | Fall Chinook salmon | 398 | 5011 | 580 | 8290 |
| | Coho salmon | 3789 | 3664 | 5922 | 907 |
| | Chum Salmon | 0 | 1584 | 0 | 3 |
| | Steelhead | 416 | 1095 | 2866 | 284 |
| | **Total Juveniles Lost** | 15957 | | 18852 | |
| | **Adult Equivalents[1]** | 52 | | 44 | |
| 2 | Fall Chinook salmon | 448 | 5430 | 530 | 8680 |
| | Coho salmon | 4469 | 5056 | 6878 | 1128 |
| | Chum Salmon | 0 | 1584 | 0 | 3 |
| | Steelhead | 2171 | 2987 | 8728 | 711 |
| | **Total Juveniles Lost** | 22145 | | 26660 | |
| | **Adult Equivalents[1]** | 73 | | 62 | |

[1] Adult equivalents for Chinook salmon were calculated using an assumed fry-to-smolt rate of 50% and a smolt-to-adult escapement rate of 0.34%. Survival rates for steelhead were a fry-to-smolt rate of 12% and a smolt-to-adult rate of 1.5% (Hurst and Haggerty 2019).

Fish that are not physiologically ready to migrate are not explicitly accounted for in our model at this time. Literature suggests that Chinook salmon subyearlings need to be at least 65 mm to tolerate the transition to saltwater (Campbell et al. 2017; Kerwin 1999). For coho salmon, Green River screw trap data from 2010-2015 demonstrate an average size at emigration of 107mm (Topping and Anderson 2016). For steelhead, Newaukum Creek screw trap data from 2014 to 2018 indicated that steelhead with no signs of smolting are less than 118 mm. We also used the current hatchery releases to determine the proportion of subyearling Chinook and coho salmon that were below the emigration thresholds identified above for the 2016-2018 releases. For the steelhead proportion, Berejikian et al. (2012) found that the rate of precocity averaged 10% (range of 2% - 20%) for three hatchery conservation programs operated in Hood Canal. Gary Marston (WDFW, personal communication) estimated that 7.5% of the smolts released from a hatchery conservation program residualized in the Duckabush River. Based on this information, the co-managers proposed that 15% is a reasonable proportion below the emigration size threshold of a steelhead release that could residualize.

Fish that do not emigrate have the potential to compete with and prey on natural-origin fish for a longer period of time relative to fish actively outmigrating, and could impart some genetic effects when they spawn naturally. To address this potential effect, NMFS recommends that, of the subset of fish measured prior to release, the proportion below a size that are unlikely to immediately emigrate be reported (Table 24). For KCC chum salmon, no metric is proposed as these fish are released as fry, and their life history is to emigrate soon after emergence. Thus, they are unlikely to delay emigration because they have no need to reach a certain size.

**Table 24. Proportion of the release below an emigration size threshold**

| Program | Lifestage | Emigration size threshold (mm) | Proportion below emigration threshold |
|---|---|---|---|
| Fall Chinook | Subyearling | 65 | 0.07 |
| Coho | Yearling | 107 | 0.03 |
| Steelhead | Smolt | 118 | 0.15 |

#### 2.5.2.3.2. Competition and predation in the estuary and ocean

##### 2.5.2.3.2.1. *Spatial and Temporal Overlap*

**Chinook Salmon**

In Puget Sound, Fresh (2006) suggests that juvenile Chinook salmon could be aggregated into four general life history strategies, referred to as *migrant fry*, *delta fry migrants*, *parr migrants*, and *yearlings*, based upon when the fish leave freshwater and their size at this time. Most Chinook salmon from Puget Sound tributaries are “ocean-type,” and arrive in estuaries as fry (< 50 mm fork length [FL]), entering natal deltas between December and April (Beamer et al. 2010; Brennan et al. 2004; Duffy 2003; Duffy 2009; Duffy et al. 2005; Simenstad et al. 1982). Some of these ocean-type juveniles pass quickly through the natal delta and enter Puget Sound (the migrant strategy), spending only days in natal deltas. Other fry remain in natal deltas for extended periods of up to 120 days (the delta strategy), where they make extensive use of small, dendritic tidal channels (channels that end in the upper end of the marsh) and sloughs in tidal wetlands (Fresh 2006).

During the late spring, fish associated with two other life history strategies (parr and yearling migrants) leave freshwater and migrate downstream to the estuary. Most Chinook salmon parr and yearlings arrive in the delta from mid-April to mid-June (Anderson and Topping 2018). Residence time and migration timing from the natal delta into Puget Sound habitats are a function of a number of factors. In general, with the exception of the migrant fry strategy, larger fish at the time of estuary entry tend to spend less time within an estuary than smaller fish. Environmental conditions, especially increasing water temperatures, may also be an important determinant of when juvenile Chinook salmon leave delta habitats (Fresh 2006).

Duffy et al. (2005) found that wild ocean-type Chinook salmon out-migrate to Puget Sound waters from March to July. The authors also found that hatchery Chinook salmon occupy nearshore Puget Sound waters soon after release and in pulses from May to June. Juvenile Chinook salmon abundance in shoreline areas of Puget Sound typically peaks in June and July, although some are still present in shoreline habitats through at least October.

Evidence indicates that all Chinook salmon populations in the ESU may rear throughout the Salish Sea for varying periods of time (Duffy 2003; Fresh 2006). Juvenile Chinook salmon may rear in Puget Sound for one to seven weeks, but certain stocks may become resident in the Salish Sea and remain there until maturity (commonly called "blackmouth"; Simenstad et al. 1982). Recent studies indicate that, upon release, substantial fractions (approximately 30%) of most

hatchery stocks of Chinook salmon adopt the blackmouth life history strategy (Chamberlin et al. 2011; O'Neill and West 2009).

**Sockeye Salmon**

Sockeye salmon usually enter marine waters in the spring, from late April to early June as smolts, but there are some populations that enter salt water as fry (Thorpe 1994). For some populations, fish may reside in estuaries, where they feed on copepods, insects, amphipods, euphausids, and fish larvae (Burgner 1991). In general, most sockeye have moved out of the estuaries by late summer into the ocean (Burgner 1991; Thorpe 1994).

**Steelhead**

Evidence indicates that because steelhead attain a relatively large size in freshwater prior to smoltification (approximately 150–220 mm (Ward et al. 1989), migrants may move rapidly through estuaries (Quinn 2005) or use deeper water habitat offshore (Moore et al. 2010). Beamish et al. (2003) reported that juvenile steelhead entering the Salish Sea generally migrate offshore into oceanic waters of the Gulf of Alaska, and are rarely found close to shore (Hartt and Dell 1986; Pearcy and Masuda 1982). In a telemetry study of steelhead migration behavior and survival in Hood Canal and Puget Sound, Moore et al. (2010) reported that steelhead did not favor migration along shorelines. The authors suggested that Hood Canal provides rearing habitat for steelhead and does not function simply as a migratory corridor, with residence times averaging around 15-17 days.

Once juvenile steelhead enter coastal waters, they move quickly offshore to oceanic feeding grounds (Burgner et al. 1992; Daly et al. 2014). Puget Sound steelhead appear to migrate quickly through estuaries (Moore et al. 2010). In oceanic waters off Washington State, Daly et al. (2014) determined that juvenile steelhead moved quickly offshore from near-coastal habitats and were associated with shelf waters for only a short period after their migration from freshwater.

**Coho Salmon**

Coho salmon do not reside for long in estuaries and generally enter ocean waters in the spring (late April through early June) (Thorpe 1994). Simenstad et al. (1982) found that a small proportion (3-5%) of juvenile coho salmon may remain in the estuaries of Puget Sound and feed on decapod larvae, amphipods, euphausids, and fish larvae, but the overall majority move through the estuary to the ocean.

**Chum Salmon**

Most chum salmon fry begin their downstream migration to saltwater within one or two days of emergence, which can occur as early as December, but usually occurs from February through May. Timing of entry into salt water is correlated with the warming of the nearshore waters and the accompanying plankton blooms (Salo 1991). Chum salmon juveniles of early-returning adults tend to enter estuaries before juveniles of late-returning fish (Koski 1975 in NMFS 2002).

Some chum salmon fry remain near the mouth of their natal river when they enter an estuary, but most disperse within a few hours into tidal creeks and sloughs up to several kilometers from the mouth of their natal river. In Hood Canal, initial distribution in salt water of the juveniles is widespread, and then becomes more shoreline oriented (Bax 1983a; Schreiner 1977 in NMFS 2002). Migration rates of chum salmon in nearshore areas depend upon such factors as fish size, foraging success and environmental conditions (currents). Habitat use appears to be strongly size dependent (Fresh 2006). Observed residence times in estuaries range from 4 to 32 days, with a period of about 24 days being the most common (Johnson et al. 1997).

Small chum salmon fry (< 50-60 mm) tend to migrate along the shoreline in shallow water, less than two meters in depth. As chum salmon fry increase in size to more than 60 mm, they expand the habitats they use to include nearshore surface waters. Chum salmon abundance in nearshore areas peaks in May and June. Abundance after June declines markedly as chum salmon move farther offshore and migrate out of Puget Sound, although some are still found in nearshore areas through October (Fresh 2006).

From the discussion above, it is clear that there is a high likelihood of spatial and temporal overlap of juvenile salmonids (hatchery- and natural-origin) in the estuaries and nearshore environments of Puget Sound (Table 25). However, it appears that juvenile Chinook and chum salmon use estuaries and nearshore environments to a larger degree than other species, and therefore may be potentially more affected by ecological interactions with other juveniles of the same species, hatchery fish, and other species. Thus, the next section focuses on these two species.

**Table 25. Periodicity of juvenile salmon and steelhead entry and residence time in Puget Sound estuaries.**

<table>
<tr><th>Species</th><th>Life Stage/ history</th><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th></tr>
<tr><td rowspan="3">**Chinook salmon**</td><td>Fry</td><td colspan="3">Entry</td><td colspan="8">Residence</td><td></td></tr>
<tr><td>Parr</td><td></td><td></td><td></td><td></td><td colspan="3">Entry</td><td colspan="3">Residence</td><td></td><td></td></tr>
<tr><td>Yearling</td><td></td><td></td><td></td><td></td><td colspan="3">Entry</td><td colspan="3">Residence</td><td></td><td></td></tr>
<tr><td>**Sockeye**</td><td>Yearling</td><td></td><td></td><td></td><td></td><td colspan="3">Entry</td><td colspan="2">Residence</td><td></td><td></td><td></td></tr>
<tr><td>**Steelhead**</td><td>Yearling</td><td></td><td></td><td></td><td></td><td colspan="3">Entry</td><td>Res.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>**Coho**</td><td>Yearling</td><td></td><td></td><td></td><td></td><td colspan="3">Entry</td><td>Res.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>**Chum**</td><td>Subyearling</td><td></td><td></td><td colspan="4">Entry</td><td colspan="4">Residence</td><td></td><td></td></tr>
</table>

### 2.5.2.3.2.2. *Competition*

The early estuarine and nearshore marine life stage, when natural-origin fish have recently entered the estuary and populations are concentrated in a relatively small area, is a critical life history period. Mortality was found to be greater during the first few weeks of steelhead marine residence, but decreased substantially after the migrating steelhead enter the Pacific Ocean (Goetz et al. 2015; Moore et al. 2015; Moore et al. 2010). Some researchers have hypothesized that there may be short-term instances where food is in short supply, and growth and survival declines as a result (Duffy 2003; Pearcy and McKinnell 2007; Rensel et al. 1984). As juvenile salmon released from the proposed programs arrive in Puget Sound estuaries, they may compete

with other salmon and steelhead in areas where they co-occur, if shared resources are limiting. Studies suggest that marine survival rates for salmon can be density dependent, and thus possibly a reflection of the amount of food available (Brodeur 1991; Holt et al. 2008; Rensel et al. 1984). Fresh (1997) summarized information concerning competition in marine habitats and concluded that food is the most limiting resource in marine habitats. The degree to which food is limiting depends upon the density of prey species and food production.

Most of the hatchery-origin Chinook salmon released from hatcheries being evaluated in this Opinion are subyearlings released in May and June (Table 5). These fish will most likely reach marine waters within weeks, and potentially interact with natural-origin fish that will be rearing in estuarine waters at the same time. Davis et al. (2018) examined size-class and origin-level differences throughout a gradient of delta habitat types. Wild (unmarked) and hatchery juveniles exhibited distinct habitat use patterns whereby unmarked fish were captured more frequently in tidally influenced freshwater and mesohaline emergent marsh areas, while hatchery fish were caught more often in the nearshore intertidal zone.

Consequently, hatchery fish were less likely to consume the energy-dense terrestrial insects that were more common in freshwater and brackish marshes. Stable isotope signatures from muscle and liver tissues corroborated this finding, showing that unmarked juveniles had derived 24–31% of their diets from terrestrially sourced prey, while terrestrial insects only made up 2–8% of hatchery fish diets. This may explain why unmarked fish were in better condition than hatchery fish (also see Daly et al. 2012; Daly et al. 2014) and had stomach contents that were 15% more energy-rich than those of hatchery fish. Davis et al. (2018) did not observe strong evidence for trophic overlap in juvenile Chinook salmon of different rearing origins, but their results suggest that hatchery-origin juveniles could be more sensitive to diet-mediated effects on growth and survival.

Interactions and effects likely diminish as hatchery- and natural-origin fish disperse into the main body of the Salish Sea and into the Pacific Ocean. Assessment of the effects of hatchery fish on natural-origin steelhead and Chinook salmon in the Salish Sea is problematic because there is a lack of basic information about what shoreline habitats are preferred by steelhead and Chinook salmon, their duration of habitat use, and their importance (Fresh 2006; Moore et al. 2010). Researchers have looked for evidence that marine area carrying capacity can limit salmonid survival (Beamish et al. 1997; HSRG 2004a). Some evidence suggests density-dependence in the abundance of returning adult salmonids (Bradford 1995; Emlen et al. 1990; Lichatowich et al. 1993), and/or is associated with cyclic ocean productivity (Beamish and Bouillon 1993; Beamish et al. 1997; Nickelson et al. 1986). Naish et al. (2008) could find no systematic, controlled study of the effects of density on natural-origin salmon, or of interactions between natural- and hatchery-origin salmon, nor on the duration of estuarine residence and survival of salmon. The Salish Sea marine ecosystem was until recently believed to be stable, internally regulated and largely deterministic. The current view is that Puget Sound is dynamic, with much environmental stochasticity and ecological uncertainty (Francis 2002; Mahnken et al. 1998).

From the scientific literature reviewed above, the influence of density-dependent interactions on growth and survival is likely small compared with the effects of large scale and regional environmental conditions. While there is evidence that hatchery production of pink and chum

salmon in Alaska, Japan, and Russia, can affect natural-origin salmon survival and productivity in the Northeast Pacific Ocean (Ruggerone et al. 2011; Ruggerone et al. 2010) , the degree of impact is not yet understood or predictable. Large-scale hatchery production may exacerbate density dependent effects when ocean productivity is low. Puget Sound-origin salmonid survival may be intermittently limited by competition with almost entirely natural-origin odd-year pink salmon originating from Salish Sea watersheds (Ruggerone and Goetz 2004), particularly when ocean productivity is low (Beamish and Bouillon 1993; Beamish et al. 1997; Mahnken et al. 1998; Nickelson et al. 1986). However, in studies of post-release migration and survival for natural and hatchery-origin steelhead smolts in Hood Canal and Central Puget Sound, predation by birds, marine mammals, and perhaps, other fish appears to be the primary factor limiting abundance of smolts reaching ocean rearing areas, not competition (Moore et al. 2010).

Green River hatchery-origin smolts migrating in marine waters exhibited an early offshore movement and a strong northward and westward seaward-bound orientation. Moore et al. (2015) found that natural-origin steelhead emigrating in early-April and late-May had a higher probability of survival than those migrating in early-and mid-May. The authors hypothesized that lower survival in the first half of May was related to consistent hatchery releases of coho and steelhead during the first week of May. However, their findings are confounded by results from the Skagit River, which indicate that hatchery-origin fish had higher freshwater and early-marine survival rates than natural-origin steelhead, making it difficult to speculate how hatchery-releases, which survived at a higher rate, could reduce the survival rate of natural-origin fish. Thus, competition from hatchery-origin steelhead in Puget Sound appears to be short in duration because steelhead are actively migrating offshore and seaward into areas where the fish may disperse more widely and where food resources are more plentiful.

Competition for food resources in Puget Sound marine areas between hatchery-origin chum salmon and Chinook salmon and steelhead is not likely a substantial risk factor. Spatial and temporal differences in emigration behaviors and residence time in Puget Sound between Chinook salmon, steelhead, and the hatchery chum salmon (fed fry) (Duffy 2003; Fresh 2006; Rensel et al. 1984), size differences at release, and partitioning of available food resources in marine areas (Duffy 2003) limit the risk of any substantial competition effects. For example, juvenile chum salmon fry released into Hood Canal in early February and March moved offshore within a few weeks, but fish released in April and early May tended to remain inshore initially, moving offshore in summer (Bax 1983b) . Chum salmon fry also seem to inhabit shallow surface waters (Schreiner 1977), likely leading to different food resources than the larger and more deep water dwelling steelhead and Chinook salmon.

#### 2.5.2.3.2.3. *Predation*

Newly released hatchery-origin yearling salmon and steelhead may prey on juvenile salmon and steelhead in the freshwater and marine environments (Hargreaves and LeBrasseur 1986; Hawkins and Tipping 1999; Pearsons and Fritts 1999). Chinook salmon, after entering the marine environment, generally prey upon fish one-half their length or less and consume, on average, fish prey that is less than one-fifth of their length (Brodeur 1991). During early marine life, predation on Chinook salmon will likely be highest in situations where large, yearling-sized hatchery fish encounter fry (Rensel et al. 1984). For example, Beauchamp and Duffy (2011) estimated that older Chinook salmon (>300 mm FL; blackmouth) during June-August could

potentially consume 6 to 59% of age-0 juvenile Chinook salmon recruiting into marine waters in the Puget Sound. The estimate depends on whether a very conservative estimate (6% Chinook in diet) or reasoned assumptions (20% Chinook in diet in May and June then allowed to decline daily via linear interpolation) were used.

Conversely, for the non-blackmouth life histories, results from Seiler et al. (2004) suggest that the individual sizes of Chinook salmon successfully transitioning to the marine environment are too large for predation by co-occurring hatchery-origin fish. Likely reasons for apparent low predation rates on Chinook salmon juveniles by larger Chinook salmon are described by Cardwell and Fresh (1979): (1) due to rapid growth, natural Chinook salmon are not as accessible and are better able to elude predators; (2) because Chinook salmon have dispersed, they are present in low densities relative to other fish; and (3) there has either been learning or selection for some predator avoidance.

Low predation rates have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012). Hatchery steelhead release timing and protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook fry, which had already emigrated or had grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead entered the rivers (Sharpe et al. 2008).

Chum salmon fry released through hatchery programs are physically too small in individual size to consume Chinook salmon and steelhead present in marine areas where chum salmon may interact with those species. Hatchery-origin salmon and steelhead predation on natural-origin steelhead in estuaries is unlikely, due to the large size of natural-origin steelhead smolts relative to the co-occurring hatchery salmon. In addition, low predation rates have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012).

#### 2.5.2.3.2.4. *Summary*

Based on the information available at this time, it is apparent that some overlap in time and space occurs between species and between hatchery- and natural-origin fish of the same species in the estuaries of Puget Sound. Effects may be more pronounced in nearshore marine waters adjacent to river mouths where salmon may initially be concentrated. Interactions and effects likely diminish as the fish disperse into the main body of Puget Sound and into the Pacific Ocean because overlap in resource use, and direct contact become less likely. However, whether this leads to either inter-or intra-specific competition and predation is less certain. In years of poor food productivity, releases of millions of hatchery fish may negatively affect natural-origin juveniles in the marine environment. However, because of the variable nature of food productivity, it is difficult to quantitatively account for interactions of hatchery fish on natural-origin fish in the estuary and marine environments, but a qualitative account of potential interactions can be made based on the knowledge we do have. This exercise suggests that the highest consistent potential interactions occur between natural- and hatchery-origin fish of the same species (Table 26).

**Table 26. Likelihood and rationale for competitive interactions between juvenile salmon and steelhead species.**

| Natural Species | Proposed Action Hatchery Species | | | | |
|---|---|---|---|---|---|
| | **Yearling Chinook** | **Subyearling Chinook** | **Coho** | **Chum** | **Steelhead** |
| **Yearling Chinook** | High: same habitat, timing and body size | Low: different habitat and timing | Low: different habitat, timing, body size | Low: different habitat and timing | Medium: different habitat and body size, same timing |
| **Subyearling Chinook** | Low: different habitat and timing | High: same habitat, timing and body size | Medium: different habitat and body size, same timing | Medium: different habitat and body size, same timing | Low: different timing and body size |
| **Sockeye** | Low: different habitat | Low: different habitat | Low: different habitat | Low: different habitat and timing | Low: different timing and body size |
| **Chum** | Low: different habitat and timing | Medium: different habitat and body size, same timing | Medium: different habitat and body size, same timing | High: same habitat, timing and body size | Low: different timing and body size |
| **Steelhead** | Medium: different habitat and body size, same timing | Low: different timing and body size | Low: different timing and body size | Low: different timing and body size | High: same habitat, timing and body size |

Based on a review of the scientific literature, NMFS's conclusion is that the influence of density-dependent interactions on the growth and survival of salmon and steelhead is likely small compared with the effects of large-scale and regional environmental conditions and, while there is evidence that large-scale hatchery production can affect salmon survival at sea, the degree of effect or level of influence is not yet well understood or predictable. The same is true for estuaries. At best, during years of limited food supply, juvenile fish survival and size may be reduced. Hatchery enhancement of salmon and steelhead populations could exacerbate density-dependent effects during years of low ocean productivity.

### 2.5.2.3.3. Naturally-produced progeny competition

Naturally spawning hatchery-origin salmon and steelhead are likely to be less efficient at reproduction than their natural-origin counterparts (Christie et al. 2014), but the progeny of such hatchery-origin spawners are likely to make up a sizable portion of the juvenile fish population for those areas where hatchery-origin fish are allowed to spawn naturally. This is actually a desired result of the integrated recovery programs. Therefore, the only expected effect of this added production is a density-dependent response of decreasing growth and increased competition/predation when habitat capacity is being approached. However, ecological impacts on both listed Chinook salmon and steelhead may increase in the future if the Chinook salmon and steelhead populations grow.

Because fall Chinook, coho, and fall chum salmon historically coexisted in substantial numbers with steelhead, it follows that there must have been adequate passage and habitat to allow all species to be productive and abundant. It does not follow automatically, however, that the

historical situation can be restored under present-day conditions. Habitat and passage conditions have changed considerably over time. Should the situation arise where salmon and steelhead production is limiting natural production of listed salmon species, recovery planners would have to prioritize species. NMFS expects that the monitoring efforts via juvenile screw trapping would detect negative impacts before they reach problematic levels.

#### 2.5.2.3.4. Disease

The risk of pathogen transmission and subsequent disease outbreaks in natural-origin salmon and steelhead is low for the programs included in this proposed action. This is because the water treatment system at the Keta Creek Complex was recently upgraded in 2015 to include sand filtration and UV light. This has eliminated many of the historical fish health issues seen here such as external parasites, and erythrocytic inclusion body syndrome (EIBS). Both the Palmer and Icy Creek rearing ponds are supplied with spring water, which is known to be pathogen free, and eliminates the risk of pathogen infection once fish are moved to these locations for final rearing. In addition, there have been no detections of any exotic pathogens for any of the programs included in the Proposed Action. It is known that *Vibrio spp.* can pose a problem for coho held in net pens, but neither the Elliott Bay nor the Des Moines net pens have a history of vibriosis. Stewart (2018) did note that an epizootic occurs annually in the summer months at the Keta Creek Hatchery when temperatures are warm and flows are low. Overall mortality can be as high as 10% of the coho production, but no infectious agents have been connected to this condition despite an intensive search using conventional culture assays and histopathology. Coho that survive do not seem to have any long lasting negative effects.

Furthermore, treatments for the pathogens responsible for outbreaks in Table 28 usually are effective within hours-14 days after treatment begins depending on the pathogen. Medicated feeds are feeds mixed with an antibiotic such as Florfenicol for *F. psychrophilum*, which causes Coldwater Disease. Formalin is usually administered as a drip into rearing containers to achive a certain concentration. For *Ichthyobodo spp*. (i.e., Costia), treatment last for about one hour (Bryan Quinton, WDFW, personal communication, October 28, 2018). Thus, the amount of time available over which shedding of pathogens could occur is limited.

There are a few pathogens detected within juvenile fish for which there is no known treatment or for which treatments with therapeutants may not be completely effective. However, fish health protocols are designed to prevent and control outbreaks with these pathogens. For example, to prevent outbreaks and reduce the amplification of *Renibacterium salmoninarum* in natural environments, hatchery staff may cull fish with high levels of the bacteria (NWIFC and WDFW 2006). These control measures have proven effective in controlling pathogens as indicated by the low number of outbreaks.

**Table 27. Pathogen detections in hatchery juveniles that are part of the proposed action.**

| Program | Pathogen Detected | | | |
|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 |
| Keta Creek Complex coho | NA | *Flavobacterium psychrophilum*[1], *Renibacterium salmoninarum; Loma salmonae; Myxsoma squamilis* | | |
| Keta Creek Complex fall chum | NA | None | | |

| | | | | |
|---|---|---|---|---|
| Soos Creek fall Chinook salmon | *Ichthyobodo sp., A. salmonicida, N. salminicola, Renibacterium salmoninarum* | *Ichthyobodo sp., N. salminicola, R. salmoninarum* | *N. salminicola R. salmoninarum,* | NA |
| Soos Creek coho | *Ichthyobodo sp., F. psychrophilum, N. salminicola* | | | NA |
| Green River Native Winter Steelhead | *Icthyopthirius miltifiliis, F. psychrophilum, N. salminicola, A. salmonicida* | *N. salminicola* | *N. salminicola* | NA |
| Green River Summer Steelhead | | | | |

Sources: (Bryan Quinton, WDFW, Personal Communication, October 28, 2018; Stewart 2018)
[1] After detection coho are fed medicated feed to prevent an outbreak 1-2 times from March-April.

**Table 28. Disease outbreaks in program juveniles that are part of the proposed action.**

| Program | Pathogen | Date(s) | Treatment/control |
|---|---|---|---|
| Soos Creek Coho | *F. psychrophilum* | March 2015 and 2016 | medicated feed |
| Soos Creek Coho | *Ichthyobodo sp.* | February-March 2015, 2016 | formalin |
| Soos Creek coho and fall Chinook, Green River summer steelhead, Green River native winter steelhead | *N. salmincola* | 2015, 2016, 2017 | none |
| Soos Creek fall Chinook | *Ichthyobodo sp.* | March-April 2015, 2016 | formalin |
| Soos Creek fall Chinook | *R. salmoninarum* | December 2015; November 2016, 2017 | medicated feed |
| Soos Creek coho and fall Chinook, Green River summer steelhead | *A. salmonicida* | May 2015 | medicated feed |
| Green River summer steelhead | *F. psychropilum* | April 2015 | medicated feed |
| Green River summer steelhead | *Icthyopthirius multifilliis* | June 2015 | formalin |

Sources: (Bryan Quinton, WDFW, personal communication, October 28, 2018)

### 2.5.2.4. Factor 4. Research, monitoring, and evaluation

RM&E actions can cause harmful changes in behavior and reduced survival; such actions include, but are not limited to:

- Observation during surveying
- Collecting and handling (purposeful or inadvertent)
- Holding the fish in captivity, sampling (e.g., the removal of scales and tissues)
- Tagging and fin-clipping

**Observing/Harassing**

Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water, or behind/under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. These

avoidance behaviors are expected to be in the range of normal predator and disturbance behaviors.

**Capturing/handling**

Any physical handling or psychological disturbance is known to be stressful to fish. Decreased survival can result from high stress levels because stress can be immediately debilitating, and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). Primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and holding vessel), dissolved oxygen conditions, the amount of time fish are held out of the water, and physical trauma. Stress increases rapidly if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding.

**Fin clipping and tagging**

Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied, but fin clips do not generally alter fish growth (Brynildson and Brynildson 1967; Gjerde and Refstie 1988). Mortality among fin-clipped fish is variable, but can be as high as 80% (Nicola and Cordone 1973). In some cases, though, no significant difference in mortality was found between clipped and un-clipped fish (Gjerde and Refstie 1988; Vincent-Lang 1993). The mortality rate typically depends on which fin is clipped. Recovery rates are generally higher for adipose- and pelvic-fin-clipped fish than for those that have clipped pectoral, dorsal, or anal fins (Nicola and Cordone 1973), probably because the adipose and pelvic fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). However, some work has shown that fish without an adipose fin may have a more difficult time swimming through turbulent water (Buckland-Nicks et al. 2011; Reimchen and Temple 2003).

In addition to fin clipping, PIT tags and/or CWTs may be used. PIT tags are inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled. Tagging needs to take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a recovery holding tank. Most studies have concluded that PIT tags generally have very little effect on growth, mortality, or behavior. Early studies of PIT tags showed no long-term effect on growth or survival (Prentice et al. 1987; Prentice and Park 1984; Rondorf and Miller 1994). In a study between the tailraces of Lower Granite and McNary Dams (225 km), (Hockersmith et al. 2000) concluded that the performance of yearling Chinook salmon was not adversely affected by orally or surgically implanted sham radio tags or PIT tags. However, Knudsen et al. (2009) found that, over several brood years, PIT tag induced smolt-adult mortality in Yakima River spring Chinook salmon averaged 10.3% and was at times as high as 33.3%.

Coded-wire tags are made of magnetized, stainless-steel wire and are injected into the nasal cartilage of a salmon and thus cause little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs should be inserted are similar to those required for

PIT tags. A major advantage to using CWTs is that they have a negligible effect on the biological condition or response of tagged salmon (Vander Haegen et al. 2005); however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

Mortality from tagging is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release—it can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

RM&E in the Green River Basin for adults includes foot and boat spawning ground surveys that count spawning fish and sample carcasses for scales, otoliths, adipose-fin clips, CWTs, and tissues for DNA analysis. The same level and types of biological sampling would occur for some species escaping to the hatcheries and collected as broodstock. The effects of these activities on ESA-listed adult salmon and steelhead are confined to visual observations during spawning ground surveys that may lead to avoidance behavior and temporary displacement of ESA-listed fish from preferred areas until surveyors move through a stream reach, but no more than would be expected from normal predator avoidance behaviors.

Juvenile outmigrant trapping using a rotary screw trap in the mainstem Green River is conducted annually. Data collected through operation of the juvenile out-migrant trap allows assessment of emigrating natural- and hatchery-origin fish abundance and overlap in timing between natural-origin species and newly released hatchery-origin fish (for releases upstream of Big Soos Creek). Other data collected at the trap used to assess hatchery effects are fish size, origin (marked/tagged vs. unmarked/untagged), and other biological data (e.g., tissues sampled for genetic analyses). The effects of take associated with these activities were analyzed and determined not to result in a decrease in the likelihood of survival and recovery of the listed species (NMFS 2017c; NMFS 2018b). For the Puget Sound Steelhead DPS, up to 2% of the juvenile proportion, and 6% of the adult proportion of the DPS are anticipated to be handled, with < 1% mortality. For the Puget Sound Chinook Salmon ESU, up to 12% of the juvenile proportion and < 1% of the adult proportion are anticipated to be handled, with < 1% mortality. We expect these effects to continue in the same manner during implementation of the proposed action.

### 2.5.2.5. Factor 5. Operation and maintenance of hatchery facilities

Effects on listed fish from operation and maintenance activities associated with the proposed hatchery programs are negative.

## Screening

A number of facilities are not anticipated to have any effects on ESA-listed salmon and steelhead. Intake screens on Big Soos Creek were rebuilt in the summer of 2018, to bring the screens into compliance with current NMFS criteria (NMFS 2011a). The intakes for the Icy Creek Hatchery and the Marine Technology Center are located below an area of extremely steep stream gradient, which precludes natural-origin salmonids from using Icy Creek and "North Creek" for spawning or rearing (WDFW 2013; WDFW 2014b; WDFW 2014c). Anadromous fish are not present upstream of the water intakes for Palmer Ponds, the Miller Creek Hatchery, and the Keta Creek Complex (Muckleshoot Indian Tribe 2014; Muckleshoot Indian Tribe and Suquamish Indian Tribe 2017). Screening at the Flaming Geyser intake was replaced in 2012 and meets current NMFS Anadromous Salmonid Passage Facility Design Criteria (NMFS 2011a). The Des Moines Marina Net Pen and the Elliott Bay Net Pen programs would operate using mesh sizes on the net-pens containing hatchery-origin coho salmon smolts (Muckleshoot Indian Tribe and Suquamish Indian Tribe 2017) that are unlikely to pose any measurable risks of entrainment and mortality to listed fish in marine waters because of the passive flow of sea water.

## Water Withdrawals

Facilities that withdraw a relatively large proportion of water over a relatively large diversion distance may present risks to the migration and survival of listed salmon and steelhead. For the facilities analyzed in this Proposed Action, there are no facilities that NMFS believes are a risk for several reasons; (1) no listed fish are upstream, (2) diversion distance is relatively short, (3) water use is non-consumptive, (4) the proportion of water withdrawn is relatively low, and (5) the water source is groundwater.

For the Icy Creek Rearing Ponds, Palmer Ponds, the Marine Technology Center, and the Keta Creek complex, no listed fish occur upstream of the intakes. In addition, water is diverted only a short distance for most of these facilities (≤ 0.3 km) and use is non-consumptive. Furthermore, withdrawal estimates are from June when facilities are most likely to be using the maximum water right because fish are on hand just before release. Water withdrawals at facilities that only use groundwater, are unlikely to affect anadromous fish (i.e., Miller Creek Hatchery). The two net pen programs only use passively supplied marine water, which is not diverted and is non-consumptive, and thus have no effect on salmon and steelhead (Table 29). For the above reasons, withdrawal of water up to permitted levels from these facilities is unlikely to lead to a lowering of stream flow that would affect listed fish migration and survival.

**Table 29. Water source, use, and discharge by salmon and steelhead hatchery facilities.**

| Facilities | Surface Water (cfs) | Water Diversion Distance (km) | Water source | Discharge Location | Mean Monthly Discharge (cfs) | Maximum Percent Surface Water Diverted[1] |
|---|---|---|---|---|---|---|
| Soos Creek Hatchery | 37.64 | 0.02 | Big Soos Creek | Big Soos Creek | 90[2] | 42 |
| Icy Creek Rearing Ponds | 20.0 | <0.03 | Icy Creek | Icy Creek | 2.2/13[3] | 100 |
| Palmer Rearing Ponds | NA | NA | NA | Green River | NA | NA |

| | | | | | | |
|---|---|---|---|---|---|---|
| Flaming Geyser Ponds | 1.5 | 0.05 | Cristy Creek | Cristy Creek | NM | 100 |
| Fish Restoration Facility | Up to 27.0 | 1.6 | Green River | Green River | 877[4] | 3 |
| Marine Technology Center | Up to 5.0 | 0.05 | North Creek | Puget Sound | NM | 100 |
| Keta Creek Complex | 10.55 | 0.3 | Crisp Creek | Crisp Creek | 6.5[5] | |
| Miller Creek Hatchery | NA | NA | Miller Creek | Miller Creek | NA | NA |
| Elliott Bay Net Pens | NM[5] | NA | Puget Sound | NA | NA | NA |
| Des Moines Net Pens | NM[5] | NA | Puget Sound | NA | NA | NA |

[1] Maximum percentage withdrawals derived assuming hatchery use of available surface water up to the maximum permitted surface water withdrawal levels.
[2] USGS June (when the most fish are on hand) mean monthly discharge for Big Soos Creek streamflow monitoring station #12112600 for water years 2007-2017. The gage is located just upstream of the Soos Creek Hatchery.
[3] Spring and stream system is not gaged, estimates of annual minimum and maximum flow (WDFW 2013).
[4] USGS June (when the most fish are on hand) mean monthly discharge for Green River streamflow monitoring station #12106700 for water years 2007-2017.
[5] King County gage 40D for water years 1995-2015.

**Effluent**

The direct discharge of hatchery facility and marine net-pen effluent is regulated by the Environmental Protection Agency under the Clean Water Act through National Pollutant Discharge Elimination System (NPDES) permits. For discharges from hatcheries not located on Federal or tribal lands within Washington, the Environmental Protection Agency has delegated its regulatory oversight to the State. Washington Department of Ecology is responsible for issuing and enforcing NPDES permits that ensure water quality standards for surface and marine waters remain consistent with public health and enjoyment, and the propagation and protection of fish, shellfish, and wildlife (WAC 173-201A).

All hatchery facilities used by the salmon and steelhead hatchery programs are operated in compliance with NPDES permits issued by Washington Department of Ecology, or do not require a NPDES permit. NPDES permits are not needed for hatchery and net-pen facilities that release less than 20,000 pounds of fish per year or feed fish less than 5,000 pounds of fish feed per year. Additionally, Native American tribes may adopt their own water quality standards for permits on tribal lands (i.e., tribal wastewater plans).

All hatchery effluent at Soos Creek Hatchery, Icy Creek Hatchery, and Palmer Ponds would be passed through a cleaning and treatment system. Funding is being sought to construct a new two-bay pollution abatement pond system at Soos Creek Hatchery, which should further reduce potential affects to water quality and listed fish (WDFW 2015). The following water quality parameters, selected by EPA and WDOE as important for determining hatchery-related water quality effects, are monitored (WDFW 2013; WDFW 2014c).

- Total Suspended Solids - 1 to 2 times per month on composite effluent, maximum effluent and influent samples.
- Settleable Solids - 1 to 2 times per week through effluent and influent sampling.
- In-hatchery Water Temperature - daily maximum and minimum readings.

Though compliance with NPDES permit conditions is not an assurance that effects on ESA-listed salmonids will not occur, the facilities use the water specifically for the purposes of rearing steelhead, which have a low mortality during hatchery residence compared to survival in the natural-environment (~ 55% compared to 7%; Bradford 1995). Because the same water used for rearing (where survival is high compared to the natural environment) is then discharged into the surrounding habitat and then further diluted once it is combined with the river water, we believe effluent will have a minimal impact on ESA-listed salmonids in the area.

Therapeutic chemicals used to control or eliminate pathogens (i.e., formaldehyde, sodium chloride, iodine, potassium permanganate, hydrogen peroxide, antibiotics), can also be present in hatchery effluent. However, these chemicals are not likely to be problematic for ESA-listed species because they are quickly diluted beyond manufacturer's instructions when added to the total effluent and again after discharge into the recipient water body. Therapeutants are also used periodically, not constantly, during hatchery rearing. In addition, many of them break down quickly in the water and/or are not likely to bioaccumulate in the environment. For example, formaldehyde readily biodegrades within 30 to 40 hours in stagnant waters. Similarly, potassium permanganate would be reduced to compounds of low toxicity within minutes. Aquatic organisms are also capable of transforming formaldehyde through various metabolic pathways into non-toxic substances, preventing bioaccumulation in organisms (EPA 2015).

#### 2.5.2.6. Factor 6. Fisheries

Fisheries in the action area not part of this proposed action, but rather are subject to separate consultation on an annual or multi-year basis, depending on the duration of the Puget Sound fishery management plan submitted by the co-managers (NMFS 2016a; Grayum 2016; Bowhay 2016; Unsworth and Bowhay 2016; Warren and Bowhay 2016). As described in Section 2.4.4, Environmental Baseline, the effects of all fisheries on ESA-listed species are expected to continue at similar levels to those described in the Environmental Baseline. NMFS (2016a); NMFS (2017a) found that the fisheries will not appreciably reduce the likelihood of survival and recovery for the listed species.

### 2.5.3. Effects of the Action on Critical Habitat

Existing hatchery facilities have not led to: altered channel morphology and stability; reduced and degraded floodplain connectivity; excessive sediment input; or the loss of habitat diversity. No new facilities or construction are directly proposed as part of the proposed actions considered in this opinion. With the exception of temporary, seasonally operated weirs on Big Soos Creek, and the marine net pens, all hatchery facilities are not located in Green River Basin waters where designated critical habitat for listed Chinook salmon and steelhead would be affected.

Proposed surface water diversion for rearing juvenile salmon and steelhead would not affect the spatial distribution of adult or juvenile ESA protected Green River Basin Chinook salmon or steelhead. Permitted water withdrawal levels for fish rearing are usually a small fraction of average annual flows in freshwater areas where listed fish may be present, and water withdrawn for hatchery use is returned near the points of withdrawal. Hatchery diversion screens protect listed juvenile Chinook salmon and steelhead from entrainment and injury, and meet current

NMFS screen criteria, or are proposed for retrofitting to meet those criteria as needed (See Section 2.5.2.5).

Compliance with NPDES permits issued for the programs would help ensure that water quality in downstream areas where listed fish may be present is not degraded. Effluent discharge for the hatchery operations is not expected to degrade water quality. Consistent with effluent discharge permit requirements developed by the Environmental Protection Agency and the Washington Department of Ecology for upland fish hatcheries, water used for fish production at Soos Creek, Icy Creek, Palmer Ponds, and Keta Creek hatcheries would be adequately treated prior to discharge into downstream areas to ensure that federal and state water quality standards for receiving waters are met and that downstream aquatic life, including salmon and steelhead, will be no more than minimally affected.

No hatchery maintenance activities are proposed in the HGMPs that would adversely modify designated critical habitat.

For these reasons, the proposed hatchery programs are not expected to pose substantial risks through water quality impairment to downstream aquatic life, including listed salmon and steelhead. No hatchery operation and maintenance activities are expected to adversely modify designated critical habitat or habitat proposed for critical designation.

## 2.6. Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. For the purpose of this analysis, the action area is described in Section 2.3. Future Federal actions, including the ongoing operation of the hydropower system, hatcheries, fisheries, and land management activities will be reviewed through separate section 7 consultation processes.

The federally approved Shared Strategy for Puget Sound Recovery Plan for Puget Sound Chinook Salmon (SSPS 2007), and the Green River Basin Salmon Habitat Plan (Watershed Resource Inventory Area 9 Steering Committee 2005) describe, in detail, the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to listed Puget Sound Chinook salmon in the Green River Basin. Future tribal, state, and local government actions will likely be in the form of legislation, administrative rules, policy initiatives, and land use and other types of permits. Government and private actions may include changes in land and water uses, including ownership and intensity, which could affect listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties.

Non-Federal actions are likely to continue affecting listed species. State, tribal, and local governments have developed plans and initiatives to benefit listed species (SSPS 2007; Watershed Resource Inventory Area 9 Steering Committee 2005). The cumulative effects of non-Federal actions in the action area are difficult to analyze because of the political variation in

the action area, and the uncertainties associated with funding and implementation of government and private actions. However, we expect the activities identified in the baseline to continue at similar magnitudes and intensities as in the recent past.

On-going State, tribal, and local government salmon restoration and recovery actions implemented through plans such as the recovery plans (NMFS 2018c; SSPS 2007) would likely continue to help lessen the effects of non-Federal land and water use activities on the status of listed fish species. The temporal pace of such decreases would be similar to the pace observed in recent years. Habitat protection and restoration actions implemented thus far have focused on preservation of existing habitat and habitat-forming processes; protection of nearshore environments, including estuaries, marine shorelines, and Puget Sound; instream flow protection and enhancement; and reduction of forest practice and farming impacts on salmon habitat. Because the projects often involve multiple parties using Federal, state, and utility funds, it can be difficult to distinguish between projects with a Federal nexus and those that can be properly described as Cumulative Effects.

With these improvements, however, based on the trends discussed above, there is also the potential for adverse cumulative effects associated with some non-Federal actions to increase such as urban development (Judge 2011). To help protect environmental resources from potential future development effects, Federal, state, and tribal laws, regulations, and policies are designed to conserve air, water, and land resources. A few examples include the Federal Navigable Waters regulations of the Clean Water Act, and in Washington State, various habitat conservation plans (HCPs) have been implemented, such as the Washington Department of Natural Resources (DNR) Forest Practices HCP (Washington Department of Natural Resources (DNR) 2005).

In Washington, local land use laws, regulations, and policies will also help protect the natural environment from future development effects. For example, the Puget Sound Regional Council (PSRC) developed Vision 2040 to identify goals that support preservation and restoration of the natural environment ongoing with development through multicounty policies that address environmental stewardship (Puget Sound Regional Council 2009). Vision 2040 is a growth management, environmental, economic, and transportation strategy for central Puget Sound. These objectives also include preserving open space, focusing on sustainable development, and planning for a comprehensive green space strategy. Other local policies and initiatives by counties and municipalities include designation of areas best suited for future development, such as local sensitive areas acts and shoreline protection acts.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult, if not impossible, to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline section.

## 2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section,

NMFS adds the effects of the proposed action (Section 2.5.2) to the environmental baseline (2.4) and to cumulative effects (2.6) to formulate the agency's opinion as to whether the Proposed Action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat. This assessment is made in full consideration of the status of the species and critical habitat and the status and role of the affected population(s) in recovery (Section 2.2).

In assessing the overall risk of the proposed action on each species, NMFS considers the risks of each factor discussed in Section 2.5.2, above, in combination, considering their potential additive effects with each other and with other actions in the area (environmental baseline and cumulative effects). This combination serves to translate the threats posed by each factor of the proposed action into a determination as to whether the proposed action as a whole would appreciably reduce the likelihood of survival and recovery of the listed species.

### 2.7.1. Puget Sound Chinook Salmon

Best available information indicates that the Puget Sound Chinook Salmon ESU remains threatened (NWFSC 2015). Spawner abundance is currently depressed, and population diversity, spatial structure, and productivity are also below levels required for the Green River population to recover to a self-sustaining condition (Section 2.2.1.1). The Green River population currently does not assume a primary role for recovery of the Puget Sound ESU (NMFS 2010a). Our environmental baseline considers the effects of dams, habitat condition, fisheries, and hatcheries on Puget Sound Chinook Salmon. Although all may have contributed to the listing, all factors have also seen improvements in the way they are managed/operated. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve for natural populations).

The majority of the effects of the Proposed Action on this ESU are genetic and ecological in nature, with small, localized effects from facility operation. Effects from RM&E have been covered previously (NMFS 2017c; NMFS 2018b), and the information gained from conducting the work is essential for understanding the effects of the hatchery programs on natural-origin Chinook salmon populations.

Genetic effects on the Green River Chinook salmon population are limited by the use of natural-origin broodstock, and an expected PNI of 0.5 on average is a reasonable long-term target for a population targeted for tier 2 in a recovery scenario. This PNI value is a substantial improvement from the current PNI of 0.09. However, the reality of the degraded habitat in the lower Green River, the lack of downstream fish passage at HHD, and the intention to produce more fish to expand the prey base for resident ESA-listed killer whales make achieving this goal within the first two phases extremely difficult. However, through some major modifications to the current fall Chinook salmon program, the population could achieve a PNI of 0.4 in years where natural-origin abundance is at least similar to the current value in phases 1 and 2. This PNI goal is more likely to be achieved by phase 4, once passage at HHD is possible and successful enough to allow for a self-sustaining natural-origin population component above the dam. Because the Green River population is one of 22 populations in the ESU, most populations are above critical

thresholds, and the Proposed Action substantially improves the Green River population's PNI, the Proposed Action is unlikely to have an adverse effect at the ESU level.

Our dispersion analysis concluded that Chinook salmon from the Green River Basin contribute about 6.9% of the Chinook salmon spawning naturally in the Snoqualmie River. This could increase to 10% with the increased releases sizes described in the Proposed Action. NMFS anticipates that the co-managers will continue to monitor the contribution of fish from the Green River into the Snoqualmie, and revise our analysis of pHOS in the context of the management changes to be implemented in the Chinook program, such as differential marking, to gather more information on the Palmer Pond releases. In the near term, we anticipate this level of pHOS to have only a small adverse effect on the Snoqualmie population diversity because: it is proposed to be a tier 3 population (NMFS 2010a); we recognize that pHOS is likely an overestimate of genetic effects; and we have yet to have data on a full brood year of Chinook salmon releases from Palmer Ponds.

Ecological effects on natural-origin juvenile Chinook salmon associated with hatchery program releases are equivalent to loss of about 2.8% in phase 1 and 4.0% in phase 2 from the adult return to the Green River. Based on current information, this is likely to be a maximum loss because of the assumptions and simplicity inherent in the model, and, while it could result in a decrease in adult abundance, this decrease is at a level that is likely to have little effect on the ESU. The ESU is composed of 21 other populations in addition to the Green River, and many of those populations are situated in Basins that have substantially better habitat than the Green River (e.g., Nisqually). In addition, most Chinook salmon populations are above the critical threshold and are on their way to the rebuilding threshold. As we continue to improve the model, these estimates will become more refined in the future, and will likely indicate a smaller percentage of adults that are lost from this worst case scenario. For the adult life stage, we conclude that coho and chum salmon are most likely to superimpose on Chinook salmon redds, although it is unlikely to occur to a great degree. Furthermore, as we move through the four phases, more habitat is likely to become available, decreasing the risk of redd superimposition even further.

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plan for this ESU describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed Chinook salmon. Such actions include improving habitat conditions, and hatchery and harvest practices to protect natural-origin Chinook salmon, and NMFS expects this trend to continue, potentially leading to increases in abundance, productivity, spatial structure and diversity.

The Green River Basin is severely degraded with very limited spawning and rearing habitat for anadromous species, including a decrease in the estuary's suitable habitat of ~ 99%. Development in the area, which is right outside of Seattle, WA is only likely to increase as the human population continues to grow. Despite these realities, the Chinook salmon population is still likely to achieve vast improvements in PNI under the Proposed Action; an increase in PNI from 0.1 currently to ~ 0.4 in phase 1, and potentially above 0.5 under improved habitat conditions, including fish passage at HHD. In addition, the existence of the hatchery programs ensures that fish will still exist in the Green River if natural-origin returns decrease to low levels

(< 500). Furthermore, the ecological effects of releasing hatchery fish of many species into the Green River Basin is estimated to result in a loss of no more than 4.0% of the adult equivalents. This estimate is also likely to decrease as targeted monitoring to improve model parameter estimates continues. Because the proposed action is likely to lead to improvements in the current genetics of the population, and considering the status of the Green as a tier 2 population in NMFS Population Recovery Approach out of 22 total populations in the ESU, the Proposed Action will not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU.

### 2.7.2. Puget Sound Steelhead

Best available information indicates that the Puget Sound Steelhead DPS remains threatened (NWFSC 2015). Spawner abundance is currently depressed, and population diversity, spatial structure, and productivity are also below desired levels required for the Green River population to recover to a self-sustaining condition (Section 2.2.1.3). Our Environmental Baseline considers the effects of hydropower, habitat, fisheries, and hatcheries. Although all may have contributed to the listing of the DPS, all factors have also seen improvements in the way they are managed/operated. As we continue to deal with a changing climate, management of these factors may also alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve for natural populations).

The majority of the effects of the Proposed Action on this DPS are genetic and ecological in nature, with small, localized effects from facility operation. Effects from RM&E has been covered previously (NMFS 2017c; NMFS 2018b) and included in the baseline, and the information gained from conducting the work is essential for understanding the effects of the hatchery programs on natural-origin steelhead populations.

The ecological and genetic effects on the adult life stage are limited by the proportion of hatchery-origin fish spawning naturally and the incorporation of natural-origin fish into the broodstock for integrated programs. Currently in phase 1, PNI exceeds 0.67, and, even with the addition of the FRF program in phase 2, we still anticipate PNI to meet or exceed the 0.67 value. NMFS believes this PNI target is sufficient to ensure natural selection outweighs hatchery selection. Our analysis of the ESS program, based on the present level of empirical and theoretical information currently available, suggests that gene flow levels of < 2% from the segregated summer steelhead program into natural-origin Puget Sound steelhead populations will pose only minor genetic risk potentially resulting in small reductions in fitness. Furthermore, the program will transition to the use of a more local Puget Sound stock within 12 years to minimize the genetic effects on the winter steelhead population. We believe the DPS can handle this level of risk because the Green River population is one of 32 populations in three MPGs over a large geographic area.

Ecological effects on natural-origin juvenile steelhead associated with releases from the hatchery program are equivalent to loss of about 3.7% from the adult return to the Green River in phase 1 and 5.2% in phase 2. Based on current information, this is likely to be a maximum loss because of the assumptions and simplicity inherent in the model, and, while it could result in a decrease in adult abundance, this decrease is at a level that is likely of little overall importance to the DPS, which is composed of 32 populations, because at least a few populations in each MPG have a

low probability of extinction over the coming decades. Also, while these programs may result in some steelhead loss due to juvenile competition and predation, they also are designed to help supplement steelhead abundance. In addition, as we continue to improve the model, these estimates will become more refined in the future, and will likely demonstrate a decrease in the percentage of adults that are lost. Furthermore, the loss of these potential adults may be offset by the benefits of releasing hundreds of thousands smolts to return to spawn naturally the following generation, especially when habitat may very well be limiting productivity.

Added to the Species' Status, Environmental Baseline, and effects of the Proposed Action are the effects of future state, private, or tribal activities, not involving Federal activities, within the Action Area. The recovery plan for this DPS describes the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to ESA-listed steelhead. Such actions include improving habitat conditions, and hatchery and harvest practices to protect listed steelhead DPSs, and NMFS expects this trend to continue, potentially leading to increases in abundance, productivity, spatial structure and diversity.

Habitat conditions for steelhead are the same as for Chinook salmon above; the Green River Basin is severely degraded with very limited spawning and rearing habitat for anadromous species, including a decrease in the estuary's suitable habitat of ~ 99%. Development in the area, which is right outside of Seattle, Washington, is only likely to increase as the human population continues to grow. Despite these realities, the winter steelhead population is still likely to maintain a PNI $\geq$ 0.67 under the Proposed Action. In addition, the existence of the hatchery programs ensures that fish will still exist in the Green River if natural-origin returns decline further. Furthermore, the ecological effects of releasing hatchery fish of many species into the Green River Basin is estimated to result in a loss of no more than 5.2% of the adult equivalents. This estimate is likely to decrease as targeted monitoring to improve model parameter estimates continues. Because no recovery scenario has been developed for Puget Sound steelhead, NMFS considers all populations as primary at this time. Thus, maintenance of PNI $\geq$ 0.67 preserves recovery options for the Green River. In addition, this population is one of 32 in the DPS, and any potential decreases in abundance and productivity due to the effects of the Proposed Action are small when scaled up to the DPS level. Thus, our analysis leads NMFS to conclude, after considering all factors, that the Proposed Action will not appreciably reduce the likelihood of survival and recovery of the Puget Sound Steelhead DPS.

### 2.7.3. Critical Habitat

Critical habitat for ESA-listed Puget Sound Chinook salmon and Puget Sound steelhead is described in Sections 2.2.1.2 and 2.2.1.4 of this opinion. In reviewing the proposed action and evaluating its effects, NMFS has determined that the proposed action will not degrade habitat designated as critical for listed fish. The existing hatchery facilities have not led to altered channel morphology and stability, reduced or degraded floodplain connectivity, excessive sediment input, or the loss of habitat diversity, and no new facilities or changes to existing facilities are proposed. The proposed actions include compliance with limits and strict criteria for withdrawing and discharging water used for fish rearing, and the actions will not result in any adverse modification of critical habitat.

Withdrawal of surface water at maximum permitted levels for fish rearing could decrease the quantity of water available for salmon and steelhead migration and rearing between hatchery water intake and water discharge points, potentially leading to adverse effects on designated critical habitat. However, such adverse effects on critical habitat are unlikely, because water withdrawal amounts for hatchery fish rearing during the summertime low flow periods, when any effects would be most pronounced, will be much less than the permitted maximum levels. Fish biomass at the hatchery rearing locations, and required water withdrawal amounts, would reach maximum permitted levels only in the late winter and spring months just prior to fish release dates, when the fish are at their largest size, and flows in the Green River Basin approach their annual maximums. At these times, the water withdrawals would not be a substantial proportion of the streamflow, and so critical habitat would not be adversely modified.

Steelhead and Chinook salmon populations in the Green River Basin may be adversely affected by climate change (see section 2.4). A decrease in winter snow pack resulting from predicted rapid changes over a geological scale in climate conditions in the Cascade Mountains would be expected to reduce spring and summer flows, impairing water quantity and water quality in primary fish rearing habitat located in the mainstem Green River. Predicted increases in rain-on-snow events would increase the frequency and intensity of floods in mainstem river areas, leading to scouring flows that would threaten the survival and productivity of natural- and hatchery-origin ESA-listed fish species. However, minimum flow maintenance and flood control operation of HHD could help reduce the risk and effects on listed fish, especially during the winter and spring months when the hatchery programs are withdrawing the most water. The proposed Chinook salmon and winter steelhead hatchery programs are expected to help attenuate climate change impacts over the short term by providing a refuge for the listed populations from risks affecting critical life stages for naturally produced fish through circumvention of potentially adverse natural spawning, incubation, and rearing conditions.

## 2.8. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, including effects of the Proposed Actions that are likely to persist following expiration of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of the Puget Sound Chinook Salmon ESU and the Puget Sound Steelhead DPS or to destroy or adversely modify designated critical habitat.

## 2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For purposes of this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a

point where such behaviors are abandoned or significantly altered. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not prohibited under the ESA, if that action is performed in compliance with the terms and conditions of this Incidental Take Statement (ITS).

### 2.9.1. Amount or Extent of Take

The primary form of take of ESA-listed Chinook salmon and steelhead is direct take, authorized under the 4(d) rule. However, NMFS also expects incidental take of ESA-listed salmon and steelhead will occur as a result of the proposed action for the following factors. The take pathways discussed below are:

- Genetic and ecological effects of hatchery adults on the spawning grounds
- Handling/tagging of adults at adult collection facilities
- Ecological effects of juveniles during emigration
- Ecological and genetic effects of juveniles that do not migrate

**Factor 2**: **Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities**

There is take for this factor due to three forms of harm: genetic effects, ecological effects, and adult handling/tagging and incidental mortality at adult collection facilities. For genetic effects, take occurs through a reduction in genetic diversity, outbreeding depression, and hatchery-influenced selection, which results from hatchery Chinook salmon and steelhead spawning with natural-origin fish. Additionally, take occurs through ecological effects of intraspecific hatchery adults on the spawning grounds such as competition for spawning sites and redd superimposition. Take due to these two pathways cannot be directly measured because it is not possible to observe gene flow or interbreeding between hatchery and wild fish in a reliable way, or to quantify spawning site competition or redd superimposition. For these two take pathways, NMFS will therefore rely on a single common set of surrogate take indicators: the number of hatchery-origin steelhead on the spawning grounds as defined here:

- A minimum annual PNI value for the Green River fall Chinook salmon population that corresponds with the natural-origin return for that year depicted in Figure 7 for phases 1 and 2. When natural-origin returns are < 500, PNI will drop below 0.2, as demographic concerns outweigh genetic concerns.
- A 5-year running average PNI value of ≥ 0.67 for the Green River winter steelhead population across both phases.
- Gene flow < 2.0% attributable to the ESS program for the natural winter steelhead population in the Green River measured as a 4-year running average (a full steelhead generation).
- No more than 10% of the escapement into the Snoqualmie will be from the Green River hatchery programs in phases 1 and 2 measured as a 5-year running average.

This set of take surrogate measurements is logically related to the genetic and ecological take pathways through assessment of intraspecific hatchery-origin Chinook salmon and steelhead on

the spawning grounds. If these fish spawn, they can cause both ecological and genetic effects on natural-origin spawners. Each of these take surrogates represents a significant limitation on the ability for genetic effects to exceed the amount of take that is expected to occur under the Proposed Action.

For the ecological effects of redd superimposition and spawning site competition associated with the coho salmon hatchery programs, take is expected to occur at the number of hatchery fish spawning naturally compared to the baseline numbers in Table 17. The number of hatchery-origin fish on the spawning grounds shall not increase by more than 50% based on a 5-year running average beginning in 2019 (average of 2015-2019), which equates to an additional 535 spawners. This take surrogate can be reliably measured and monitored through weir collections, CWT recoveries, and hatchery rack returns.

The third take pathway for this factor is the handling/tagging of listed hatchery and natural-origin Chinook salmon and steelhead at adult collection facilities to facilitate broodstock collection, and sampling of fish for monitoring and evaluation. The amount of incidental take of ESA-listed steelhead and fall Chinook salmon expected to occur as a result of the proposed action by this pathway is contained in Table 19.

**Factor 3: Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas**

Predation, competition, or pathogen transmission, collectively referred to as ecological interactions, between natural-origin juvenile Chinook salmon and steelhead and hatchery steelhead smolts could result in take of natural-origin Chinook salmon and steelhead. In addition, non-migrating fish could also cause genetic effects when non-migrating fish spawn naturally (particularly precocial males largely associated with steelhead). However, it is difficult to quantify this take because ecological interactions cannot be directly measured and/or observed. Thus, we will have two take surrogates, one to address the effects of migrating hatchery juveniles, and a second to address the effects of non-migrating hatchery juveniles

We will quantify the extent of take of migrating fish using travel time of juvenile hatchery fish. This is a reasonable surrogate for the take that occurs because the slower fish travel, the more time available for preying and competing on ESA-listed natural-origin juveniles in the area. Thus, take is exceeded if the average number of days required for each release group identified in Table 22 to migrate to the mouth of the river increases by more than 5 days based on a 5-year running average beginning in 2019 (years 2015-2019). In this case, the expected take from interactions will have likely been exceeded as a result of a longer average period of overlap between hatchery and natural-origin fish. This surrogate will be monitored using emigration estimates from screw traps, or other juvenile monitoring techniques developed by the operators and approved by NMFS.

Regarding take associated with non-migrating hatchery fish, NMFS will rely on a surrogate that determines what proportion of the release falls below an emigration size threshold. This is a reasonable, reliable, and measurable surrogate for incidental take because fish below the threshold are unlikely to be physiologically ready to migrate, and if the proportion of the release below the emigration size threshold exceeds the proportion in Table 24, it is a sign that more fish

may have longer freshwater residence times. Therefore, the expected take from interactions will have likely been exceeded as a result of a longer period of overlap between hatchery and natural-origin fish. This threshold will be monitored using emigration estimates from screw traps, proportion of fish below the emigration size threshold prior to release, or other juvenile monitoring techniques developed by the operators and approved by NMFS.

### 2.9.2. Effect of the Take

In Section 2.8, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy of the Puget Sound Chinook Salmon ESU or the Puget Sound Steelhead DPS or in the destruction or adverse modification of designated critical habitat.

### 2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize incidental take. NMFS shall ensure that:

1. The applicants follow all conditions specified in each authorization issued as well as guidelines specified in this opinion for their respective programs.
2. A workgroup—comprised of co-managers, NMFS, and the Army Corps of Engineers—is being developed, to be coordinated by NOAA, to plan for fish passage and the reintroduction of fish above HHD with discussions beginning in the summer of 2019.
3. The applicants provide reports to SFD annually for all hatchery programs and associated RM&E.

### 2.9.4. Terms and Conditions

The terms and conditions described below are non-discretionary, and the Action Agencies must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Action Agencies have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will lapse. NMFS shall ensure that:

1. The applicants follow all conditions specified in each authorization issued as well as guidelines specified in this opinion for their respective programs, including:
    a. Provide advance notice of any change in program operation and implementation that may increase the amount or extent of take, or results in an effect of take not previously considered.
    b. Notify NMFS SFD within 48 hours after knowledge of exceeding authorized take. The applicants shall submit a written report, and/or convene a discussion with NMFS to discuss why the authorized take was exceeded.

c. Finalize a plan to phase out use of out-of-basin steelhead broodstock. As a measure to eliminate genetic effects of out of Puget Sound ESS production on the Green River winter steelhead population, the co-managers have proposed to transition the Soos Creek Hatchery ESS program, but still maintain a release size of up to 100,000 smolts throughout the transition, to a within Puget Sound summer steelhead stock within 12 spawn years of opinion signature. A transition plan will be discussed and submitted to NMFS within one year of opinion signature. The working assumption in developing the transition plan is that an integrated hatchery program using steelhead collected from the South Fork Skykomish will be the source of broodstock for the new program.

d. No ESS collected at the hatcheries shall be released back into the natural environment as a measure to reduce straying and gene flow risks to the natural-origin steelhead population.

e. Development and submission of a steelhead sampling plan in the Green River to verify PEHC values within four months of Opinion signature.

f. Remove surplus hatchery-origin fish as needed to meet pHOS/PNI metrics for the Green River fall Chinook salmon and winter steelhead populations.

g. The co-managers contribute to studies on assessing hatchery-origin influence on the Snoqualmie population that addresses the genetic effects of strays from the Green River Chinook salmon hatchery programs.

    i. Re-evaluate the contribution of fish released from Palmer Ponds once data for an entire brood year is obtained

    ii. Provide otolith samples to the Tulalip Tribe for subyearling Chinook salmon released from Palmer Ponds

2. A workgroup—comprising co-managers, NMFS, and the Army Corps of Engineers—is developed to plan for fish passage and the reintroduction of fish above HHD with discussions beginning in the summer of 2019.

3. The applicants provide reports to SFD annually for their respective programs, including associated RM&E. All reports and required notifications are to be submitted electronically to the NMFS, West Coast Region, Sustainable Fisheries Division, APIF Branch. The current point of contact for document submission is Charlene Hurst (503-230-5409, charlene.n.hurst@noaa.gov).

    a. An annual RM&E report(s) is submitted by applicants no later than April 15 of the year following releases and associated RM&E (e.g., release/RM&E in year 2017, report due April 2018), and should include:

        i. The number and origin (hatchery and natural) of each listed species handled and incidental mortality across all activities and facilities

        ii. Hatchery Environment Monitoring Reporting

            - Number and composition of broodstock, and dates of collection
            - Numbers, dates, locations, size, coefficient of variation, and tag/mark information of released fish

- Proportion of release below the emigration size threshold in Table 24
- Survival rates of green egg-to-smolt, and smolt-to-adult
- Disease occurrence at hatcheries
- Any problems that may have arisen during hatchery activities
- Any unforeseen effects on listed fish

iii. Natural Environment Monitoring Reporting

- The number of returning hatchery and natural-origin adults and their distribution within the Green River Basin
- The number and species of listed fish encountered at each adult collection location, and the number that die
- The contribution of Chinook salmon and steelhead from these programs into all ESA-listed populations where feasible with existing stock assessment methods
- Distribution of arrival times at smolt traps for each juvenile hatchery-origin fish release
- Mean length, coefficient of variation, number, and age of natural-origin juveniles during RM&E activities
- Estimates of ESS program-related PEHC for the natural steelhead population in the Green River watershed

### 2.9.5. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a Proposed Action on listed species or critical habitat (50 CFR 402.02). NMFS has identified three conservation recommendations appropriate to the Proposed Action:

1. Currently, there is limited ability to collect adults at Palmer Ponds due to a lack of infrastructure. The ability to collect returning hatchery-origin adults at Palmer Ponds would further reduce the genetic effects of hatchery-origin Chinook salmon by removing those fish from the naturally-spawning population. Thus, NMFS recommends improvements to Palmer Ponds to allow for adult collection.
2. The co-managers will work with NMFS to continue refining the methods for the dispersion analysis.
3. NMFS will work with the co-managers to continue to refine the estimates of non-migrating juveniles from the hatchery programs.

## 2.10. Re-initiation of Consultation

As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

## 2.11. Not Likely to Adversely Affect Determinations

### 2.11.1. Hood Canal Summer Chum Salmon ESU

On June 28, 2005, NMFS listed Hood Canal Summer (HCS) chum salmon—both natural-origin and some artificially-propagated fish—as a threatened species (70 FR 37160). The species comprises all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. The ESU has two populations, each containing multiple stocks or spawning aggregations. Juveniles, typically as fry, emerge from the gravel and outmigrate almost immediately to seawater. For their first few weeks, they reside in the top two to three centimeters of estuarine surface waters while staying extremely close to the shoreline (WDFW/PNPTT 2000). Subadults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in their natal streams. HCS chum salmon spawn from mid-September to mid-October in the mainstems and lower river basins.

Natural-origin spawner abundance has increased since their 1999 ESA-listing (64 FR 14508) and spawning abundance targets in both populations have been met in some years (NWFSC 2015). Productivity was quite low at the time of the last review (Ford 2011), though rates have increased in the last five years, and have been greater than replacement rates in the past two years for both populations. For each population, spatial structure and diversity viability parameters have increased and nearly meet the viability criteria. However, only two of eight individual spawning aggregates have viable performance. Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (NWFSC 2015).

HCS chum salmon would potentially be encountered by juvenile fish released from our Proposed Action during their emigration to marine waters after release. Thus, the only anticipated effects on HCS chum salmon are likely to be competition and predation. Due to the vast number of fall chum salmon in the Puget Sound area, it is likely that releases of hatchery fish from the Proposed Action are more likely to encounter fall chum fry and adults than summer chum fry and adults in the marine environment. Also, summer chum are likely to emigrate to the marine area in March (Tynan 1997), earlier than most of the releases of hatchery fish in the Green River. Thus, NMFS believes that our Proposed Action is likely to only have discountable effects on HCS chum salmon.

### 2.11.2. Ozette Lake Sockeye Salmon ESU

The Ozette Lake Sockeye Salmon ESU was listed as a threatened species in 1999 (64 FR 14528; March 25, 1999). The ESU includes all naturally spawned populations of sockeye salmon in Ozette Lake and streams and tributaries flowing into Ozette Lake, Washington. The Puget Sound Technical Recovery Team considers the Ozette Lake Sockeye Salmon ESU to comprise one historical population with multiple spawning aggregations. The primary existing spawning aggregations occur in two beach locations—Allen's and Olsen's Beaches—and in two tributaries—Umbrella Creek and Big River. The ESU also includes fish originating from two artificial propagation programs: the Umbrella Creek and Big River sockeye hatchery programs.

After hatching, most juveniles spend one winter in Ozette Lake rearing before outmigrating to the ocean as two-year-old fish during April and May (Dlugokenski et al. 1981). The fish typically spend two years in the northeast Pacific Ocean foraging on zooplankton, squid, and, infrequently, on small fishes (Scott and Crossman 1973). Migration of adult sockeye salmon up the Ozette River generally occurs from mid-April to mid-August (Washington Department of Fisheries and Washington Department of Wildlife 1993).

From 1977 to 2011, the estimated natural spawners ranged from 699 to 5,313 (NWFSC 2015), well below the 31,250 – 121,000 viable population range proposed in the recovery plan (NMFS 2009). Over the last few decades, productivity appears to have remained stable around 1. The Umbrella Creek Hatchery program has successfully introduced a tributary spawning aggregate, increasing the diversity of age at return. However, the beach spawning aggregate is considered the core group of interest for recovery; the current number of beach spawners is well below historical levels and restricted to a subset of historical spawning beaches (NWFSC 2015).

Lake Ozette sockeye salmon would potentially be encountered by juvenile fish released from our Proposed Action during their emigration to offshore marine waters after release. Thus, the anticipated effects on Lake Ozette sockeye salmon are likely to be competition and predation. Lake Ozette sockeye salmon emigrate to marine areas in April to May (Haggerty et al. 2009), and would likely reach marine areas earlier than most of the releases of hatchery fish in the Green River because they are released during the same timeframe, but have a much greater distance to travel. In addition, juvenile sockeye salmon are present close to shore from Cape Flattery to Yakutat in July and August and then move offshore in late Autumn or winter. The nearshore around the Ozette River is a productive, shallow sub-tidal environment (Haggerty et al. 2009), and it is assumed that very few if any of these fish move into Puget Sound marine areas. Thus, NMFS believes that our Proposed Action is likely to have discountable effects on Lake Ozette sockeye salmon.

## 3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or Proposed Actions that may adversely affect EFH. The MSA (Section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms,

prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on descriptions of EFH for Pacific coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

### 3.1. Essential Fish Habitat Affected by the Project

The action area of the Proposed Action includes habitat described as EFH for Chinook, pink and coho salmon. Marine EFH for Chinook, coho, and Puget Sound pink salmon in Washington, Oregon, and California includes all estuarine, nearshore and marine waters within the western boundary of the EEZ, 200 miles offshore. Freshwater EFH for Pacific salmon, includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable manmade barriers, and long-standing, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). As described by PFMC (2014), within these areas, freshwater EFH for Pacific salmon consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and adult holding habitat. Marine EFH for Chinook and coho salmon consists of three components, (1) estuarine rearing; (2) ocean rearing; and (3) juvenile and adult migration.

EFH for groundfish includes all waters, substrates and associated biological communities from the mean higher high water line, or the upriver extent of saltwater intrusion in river mouths, seaward to the 3500 meters in depth contour plus specified areas of interest such as seamounts. A more detailed description and identification of EFH for groundfish is found in the Appendix B of Amendment 25 to the Pacific Coast Groundfish Management Plan (PFMC 2016c).

EFH for coastal pelagic species includes all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the EEZ and above the thermocline where sea surface temperatures range between 10°C to 26°C. A more detailed description and identification of EFH for coastal pelagic species is found in Amendment 15 to the Coastal Pelagic Species Fishery Management Plan (PFMC 2016a).

### 3.2. Adverse Effects on Essential Fish Habitat

The biological opinion describes in considerable detail the impacts hatchery programs might have on natural-origin salmon and steelhead populations (Section 2.5.2). Naturally spawning adult salmon produced by the proposed hatchery programs may lead to effects on natural-origin salmon EFH through spawning ground competition and redd superimposition. The biological opinion describes impacts the hatchery programs might have on naturally spawning salmon populations (Section 2.5.2). The intent of the hatchery Chinook and coho salmon programs is to produce native fish that will return to marine and freshwater commercial and recreational fishing areas to augment harvests. The majority of salmon produced through the programs will be

harvested in pre-terminal and terminal area fisheries, reducing the number of salmon that would escape to spawn in freshwater EFH. A substantial proportion of hatchery-produced salmon escaping terminal area fisheries home to their hatchery releases sites, further reducing the number of hatchery salmon that escape into natural spawning areas that are part of EFH in the basin. Further, any naturally spawning hatchery coho and fall chum salmon would not overlap temporally and/or spatially to a substantial degree with natural-origin Chinook, coho, or pink salmon in natural spawning areas, limiting effects of competition or red superimposition.

The release of salmon and steelhead through the proposed hatchery programs may lead to effects on EFH through predation on and competition with juvenile Chinook, coho, and pink salmon. Coho salmon yearlings from the Elliott Bay Net-Pens and the Des Moines Marina Net Pen programs would be released directly into seawater, and there would be no effects on freshwater salmon EFH. Hatchery-origin predation on and competition with natural-origin juvenile Chinook salmon was ~4% of the natural-origin adult equivalents. It is likely to be less than this for pink salmon because pinks emigrate soon after emergence around February-March, before hatchery fish are released. Both pink and coho salmon also have greater natural-origin abundances; meaning that even if the adult equivalents are similar among species, the proportional effect would be less on those species that have larger populations. Predation on and competition with natural-origin salmon in the marine environment is possible, but is likely limited by the release of hatchery fish that are ready to emigrate to the ocean quickly and the lack of a usable estuary for rearing outside of the Green River

Regarding hatchery facility operation effects on salmon EFH, the adult salmon holding and spawning habitat, and juvenile salmon rearing locations, are not expected to be affected by the operation of the hatchery programs, as no modifications to these areas would occur. Our analysis of facility effects did not reveal any substantial concerns related to screening, water withdrawal, or effluent (see Section 2.5.2.5).

The proposed action is not likely to have adverse effects on EFH for the coastal pelagic species. Of the potential adverse effects listed in (PFMC 2016a) and (PFMC 2016b), effects of hatchery operations could be analogous to adverse effects of aquaculture; organic waste, release of high levels of antibiotics, disease, and escapees. However, these analogous concerns for hatchery operations are not likely to adversely affect coastal pelagic species because all relevant facilities have NPDES permits to minimize effects of organic waste, and antibiotics would be diluted to manufacturer labeling. Concerns of disease transfer from and escapees of salmonid species are not likely to be a concern because coastal pelagic species are not closely related to the salmonid species.

The proposed action is not likely to have adverse effects on EFH for groundfish. Of the potential adverse effects listed in (PFMC 2016b), effects on water quality is listed as a major concern of water use. However, all relevant facilities have NPDES permits to minimize effects on water quality. Altering natural flows is not a concern associated with hatchery operations because the hatcheries are not altering the flow rate in Puget Sound enough for the effects to be detectable in the groundfish EFH. Affecting prey base and entrapping fish through water withdrawal is not adversely affected by hatchery operations because water is not withdrawn within the groundfish

EFH. Finally, adverse effects associated with dams are not relevant to hatchery operations because hatchery operations do not affect how dams are operated.

In summary, the proposed action is expected to have adverse effects on EFH for Chinook, coho and pink salmon, but not for coastal pelagic species and groundfish.

### 3.3. Essential Fish Habitat Conservation Recommendations

For each of the potential adverse effects by the Proposed Action on EFH for Chinook, coho, and pink salmon, NMFS believes that the Proposed Action, as described in the HGMPs and the ITS (Section 2.9), includes the best approaches to avoid or minimize those adverse effects. The Reasonable and Prudent Measures and Terms and Conditions included in the ITS associated with ecological interactions constitute NMFS recommendations to address potential EFH effects. NMFS and BIA shall ensure that the ITS, including Reasonable and Prudent Measures and implementing Terms and Conditions, are carried out.

### 3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations, unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects [50 CFR 600.920(k)(1)].

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that, in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

### 3.5. Supplemental Consultation

The NMFS and BIA must reinitiate EFH consultation with NMFS if the Proposed Action is substantially revised in a way that may adversely affect EFH, or if new information becomes available [50 CFR 600.920(l)].

# Exhibit 12

# FINAL ENVIRONMENTAL IMPACT STATEMENT

Final Environmental Impact Statement for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin

Prepared by the
National Marine Fisheries Service, West Coast Region

NOAA FISHERIES

In Cooperation with the
Bureau of Indian Affairs, Northwest Regional Office

July 2019

THIS PAGE INTENTIONALLY LEFT BLANK

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232

June 28, 2019

Dear Recipient:

In accordance with provisions of the National Environmental Policy Act (NEPA), we announce the publication of the Final Environmental Impact Statement (FEIS) for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin.

The Washington Department of Fish and Wildlife (WDFW), Muckleshoot Indian Tribe, and Suquamish Tribe (hereafter referred to as the co-managers) have jointly submitted to the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) hatchery and genetic management plans (HGMPs) for 10 hatchery programs that would produce salmon and steelhead in the Duwamish-Green River Basin in Puget Sound. The proposed action is NOAA NMFS' determination that the co-managers' HGMPs meet the requirements of Limit 5 and Limit 6 of the 4(d) Rules for threatened salmon and steelhead. Take of threatened salmon and steelhead resulting from activities undertaken pursuant to the HGMPs for the co-managers' hatcheries would not be prohibited under the Endangered Species Act, and the programs would continue to be implemented by the co-managers.

The NOAA's Policy and Procedures for Compliance with the NEPA and Related Authorities, Companion Manual for NOAA Administrative Order 216-6A requires that NOAA prepare and publish a Record of Decision (ROD) that concludes the NEPA process for an Environmental Impact Statement (EIS). The NOAA NMFS intends to issue the ROD no sooner than 30 days after the publication of the FEIS (40 C.F.R. §1506.10).

NOAA NMFS has made available the FEIS electronically through the NMFS West Coast Region's Salmon and Steelhead Hatcheries website. The ROD will also be made available at this website.

Sincerely,

Barry A. Thom
Regional Administrator

THIS PAGE INTENTIONALLY LEFT BLANK

# Cover Sheet

| | |
|---|---|
| **Title of Environmental Review:** | Final Environmental Impact Statement for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin |
| **Responsible Agency and Official:** | Barry A. Thom, Regional Administrator<br>National Marine Fisheries Service, West Coast Region<br>7600 Sand Point Way NE, Building 1<br>Seattle, WA 98115 |
| **Cooperating Agency:** | U.S. Department of the Interior, Bureau of Indian Affairs |
| **Contact:** | Allyson Purcell<br>NMFS Salmon Management Division, West Coast Region<br>1201 NE Lloyd Blvd, Suite 1100<br>Portland, OR 97232<br>Allyson.Purcell@noaa.gov (Note: not for commenting)<br>(503) 736-4736 |
| **Location of Proposed Activities:** | The Duwamish-Green River Basin in Puget Sound, Washington State |
| **Proposed Action:** | NMFS would make a determination that the 10 hatchery and genetic management plans (HGMPs) submitted as a resource management plan (RMP) by the co-managers, meet the requirements under Limit 6 of 4(d) Rule under the Endangered Species Act (ESA) for listed Puget Sound Chinook salmon and steelhead. |
| **Abstract:** | The Washington Department of Fish and Wildlife and the Puget Sound treaty tribes jointly submitted 10 HGMPs for salmon and steelhead hatchery programs in the Duwamish-Green River Basin in Puget Sound, as an RMP. These plans describe each hatchery program in detail, including fish life stages produced and potential measures to minimize risks of negative impacts that may affect listed fish. NMFS' determination of whether the plans achieve the conservation standards of the ESA, as set forth in Limit 6 of the 4(d) Rule for listed salmon and steelhead, is the Federal action requiring National Environmental Policy Act (NEPA) compliance. The analysis within the environmental impact statement (EIS) informs NMFS, hatchery operators, and the public about the current and anticipated direct, indirect, and cumulative environmental effects of operating the 10 salmon and steelhead hatchery programs under the full range of alternatives. |

THIS PAGE INTENTIONALLY LEFT BLANK

# Summary

## Final Environmental Impact Statement for 10 Salmon and Steelhead Hatchery Programs in the Duwamish-Green River Basin

### Introduction

The National Marine Fisheries Service (NMFS) has prepared this environmental impact statement (EIS) in compliance with the National Environmental Policy Act (NEPA) after the co-managers submitted to NMFS 10 hatchery and genetic management plans (HGMPs) for salmon and steelhead in the Duwamish-Green River Basin in Puget Sound.

NMFS published a Notice of Intent to prepare an EIS for this action on May 4, 2016. After considering public comments, four alternatives were developed, and the draft EIS was published for public review and comment in November 2017. The co-managers requested consideration of an additional alternative, and a Notice of Intent to prepare a draft supplemental EIS was published in October 2018. The draft supplemental EIS was published for public review and comment in December 2018. NMFS received 39 comments from 26 letters and emails during the DEIS comment period and 36 comments from 15 letters and emails during the supplemental DEIS comment period.

NMFS evaluated Alternative 1 through Alternative 4 in the draft EIS and Alternative 5 in the draft supplemental EIS, and the final EIS incorporates the analyses from both of those EISs. NMFS has also incorporated public comments and suggestions on both the draft EIS and draft supplemental EIS, as well as more recent information on the affected resources, into this final EIS. The final EIS identifies Alternative 5 as the Preferred Alternative. In addition to identifying the Preferred Alternative, several updates and clarifications were made to the final EIS (for a summary of major changes to the draft EIS and draft supplemental EIS that are reflected in this final EIS, see the last subsection of this Summary).

Some of the major changes include:

- **HGMP Revisions and Incorporation into the final EIS**. The final EIS includes Alternative 5 (Increased Production), which was not described in the draft EIS, but was described in the subsequent draft supplemental EIS. Alternative 5, as described in this final EIS, includes changes in the Green River late winter-run steelhead program (release of 55,000 yearlings compared to 33,000 yearlings as described in the draft EIS, which was also analyzed in the draft supplemental EIS) and changes to the proposed fish restoration facility (FRF) late winter-run steelhead program (release of 250,000 steelhead yearlings compared to 350,000 yearlings as described in the draft EIS and draft supplemental EIS).

- **Southern Resident Killer Whale.** The EIS includes updated information on Southern Resident killer whale and potential competition effects with other marine mammals (i.e., Steller sea lions, California sea lions, and harbor seals) that also prey on salmon and steelhead.

- **Chinook and Steelhead Genetic Risks**. NMFS conducted a detailed genetic risk evaluation for Chinook salmon and steelhead in its biological opinion (NMFS 2019). Based on these results, NMFS included additional terms and conditions that would be a component of Alternative 5 and final HGMPs if Alternative 5 is selected in the Record of Decision (ROD) for this EIS. These terms and conditions are described and evaluated under Alternative 5 in this final EIS.

- **FRF HGMP Programs**. The draft EIS described two options for the FRF programs depending on whether fish passage would occur at the Howard Hanson Dam. After consideration of when and if fish passage would occur at the dam, which could be as late as 2030, this final EIS more realistically evaluates effects as if fish passage is not yet implemented at the Howard Hanson Dam.

Salmon and steelhead have been produced in Puget Sound hatcheries since the early 1900s. The benefit of hatcheries at the outset was to produce hatchery-origin fish for harvest purposes. Hatcheries have contributed 70 to 80 percent of the catch in coastal salmon and steelhead fisheries. As the fish's natural habitat was degraded by human development and activities like passage barriers, forest practices, and urbanization, the role of hatcheries shifted toward mitigation for lost natural production and reduced harvest opportunity. Hatchery production presents risks to natural-origin salmon and steelhead. These include genetic risks from hatchery-origin fish to natural-origin fish as a result of poor broodstock and

rearing practices, risks of competition with and predation on naturally spawned populations, and incidental harvest of natural-origin fish in fisheries targeting hatchery-origin fish.

The Washington Department of Fish and Wildlife (WDFW), Muckleshoot Indian Tribe, and Suquamish Tribe (hereafter referred to as the co-managers) have jointly submitted to the NMFS HGMPs for 10 hatchery programs that would produce salmon and steelhead in the Duwamish-Green River Basin in Puget Sound. The HGMPs describe the hatchery programs, including fish life stages produced and potential research, monitoring, and evaluation actions to minimize the risk of negatively affecting listed salmon and steelhead (Table S-1). The HGMPs have been submitted for review and approval as a resource management plan (RMP) under Limit 6 of the 4(d) Rule under the Federal Endangered Species Act (ESA). The plans are consistent with the framework of *United States v. Washington* (1974) for coordination of treaty fishing rights, non-tribal harvest, artificial production objectives, and artificial production levels.

Table S-1. ESA status of listed Puget Sound salmon and steelhead.

| Species | Evolutionarily Significant Unit/ Distinct Population Segment | Current Endangered Species Act Listing Status |
|---|---|---|
| Chinook salmon (*Oncorhynchus tshawytscha*) | Puget Sound | Threatened (96 Fed. Reg. 20802, April 14, 2014) |
| Chum salmon *(O. keta)* | Hood Canal summer-run (includes Strait of Juan de Fuca summer-run) | Threatened (76 Fed. Reg. 50448, August 15, 2011) |
| Steelhead (*O. mykiss*) | Puget Sound | Threatened (76 Fed. Reg. 50448, August 15, 2011) |
| Coho salmon (*O. kisutch*) | Puget Sound/Strait of Georgia | Species of Concern (69 Fed. Reg. 19975, April 15, 2004) |

Source: NMFS

NMFS' determination of whether the HGMPs submitted as an RMP achieve the conservation standards of the ESA, as set forth in Limit 6 of the 4(d) Rule, is the Federal action requiring NEPA compliance. Although this EIS itself will not determine whether the HGMPs submitted as an RMP meet ESA requirements—those determinations are made under the specific criteria of the ESA and the 4(d) Rule—the analyses within the EIS will inform NMFS, hatchery operators, and the public about the current and anticipated cumulative environmental effects of operating the 10 salmon and steelhead hatchery programs under the full range of alternatives.

**What is the 4(d) Rule?**

Section 4(d) of the ESA directs NMFS to issue regulations to conserve species listed as threatened. This applies particularly to "take," which can include any act that kills or injures fish, and may include habitat modification. The ESA prohibits any take of species listed as endangered; however, some take of threatened species that does not interfere with survival and recovery may be allowed.

For salmon and steelhead, the 4(d) Rule applies take prohibitions to all actions except those within the 13 limits to the rule. The limits, or exemptions, describe specified categories of activities that contribute to conserving listed salmon. A separate, but closely related, tribal 4(d) Rule creates an additional limit for tribal RMPs.

Limit 5 of the 4(d) Rule, using specific criteria, provides limits on the prohibitions of "take" for a variety of hatchery purposes, based on NMFS' evaluation and approval of HGMPs submitted by hatchery operators. Limit 6 of the 4(d) Rule provides limits on the prohibitions of "take" for joint tribal and state plans developed under *United States v. Washington* processes, including artificial production actions.

## Proposed Action

Under the Proposed Action, NMFS would determine whether the 10 HGMPs submitted as an RMP, meet the requirements of Limit 6 of the 4(d) Rule. The HGMPs for Puget Sound hatcheries would be implemented by the co-managers.

## Project Area

The project area covered in this EIS includes the places where the proposed salmon and steelhead hatchery programs would (1) collect broodstock; (2) spawn, incubate, and rear fish; (3) release fish; or (4) remove surplus hatchery-origin adult salmon and steelhead that return to hatchery facilities; and (5) conduct monitoring and evaluation activities. The project area consists of the Duwamish-Green River Basin. These 10 hatchery programs (7 current and 3 new hatchery programs) would operate using 4 hatchery facilities, 3 rearing ponds, and 2 net pens, and would produce up to 13,993,000 juvenile salmon and steelhead per year as described under the Proposed Action.

## Purpose and Need

The purpose of the Proposed Action from NMFS' perspective is to evaluate the submitted HGMPs for ESA compliance. The need for the Proposed Action is to ensure the sustainability and recovery of

Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound. NMFS will ensure it meets its tribal trust stewardship responsibilities and will also work collaboratively with the Muckleshoot Indian Tribe, Suquamish Tribe, and WDFW to protect and conserve listed species.

The co-managers' objectives in developing and submitting HGMPs and submitting them as an RMP under Limit 6 of the 4(d) Rule is to operate their hatcheries to meet resource management and protection goals with the assurance that any harm, death, or injury to fish within a listed evolutionarily significant unit (ESU) or distinct population segment (DPS) does not appreciably reduce the likelihood of a species' survival and recovery and is not in the category of prohibited take under the 4(d) Rule.

**What is an ESU? What is a DPS?**

NMFS lists salmon as threatened or endangered according to the status of their evolutionarily significant units (ESUs). An ESU is a salmon population that is 1) substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species.

In contrast to salmon, NMFS lists steelhead under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) policy for recognizing distinct population segments (DPSs) under the ESA. This policy adopts criteria similar to, but somewhat different than, those in the ESU policy for determining when a group of vertebrates constitutes a DPS. A group of organisms is discrete if it is "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors." NMFS lists steelhead according to the status of the steelhead DPS.

The co-managers also have as an objective the continued operation of salmon and steelhead hatchery programs using existing facilities for conservation, mitigation, and tribal and non-tribal fishing opportunity pursuant to the Puget Sound Salmon Management Plan implemented under *United States v. Washington,* and treaty rights preservation purposes while meeting ESA requirements. WDFW and the Puget Sound treaty tribes strive to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and steelhead and their ecosystems to sustain treaty ceremonial and subsistence fisheries, treaty and non-treaty commercial and recreational fisheries, non-consumptive fish benefits, and other cultural and ecological values.

**Relationship Between the ESA and NEPA**

The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a Proposed Action. However, each law has a distinct purpose, and the scope of review and standards of review under each statute are different.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a No-action Alternative. Public involvement promotes this purpose.

The purpose of the ESA is to conserve listed species and the ecosystems upon which they depend. Determinations about whether hatchery programs in Puget Sound meet ESA requirements are made under section 4(d) or section 7 of the ESA. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analyses and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest to the reader any conclusions relative to the ESA analysis for this action. While the NEPA ROD identifies the selected NEPA alternative, the ROD does not conclude whether that alternative complies with the ESA.

**Alternatives Analyzed in Detail**

**Alternative 1 (No Action)**

Under this alternative, NMFS would not make a determination under the 4(d) Rule for any of the 10 HGMPs, and the hatchery programs would not be exempted from ESA section 9 take prohibitions. Although other outcomes are possible, for the purposes of this EIS, NMFS has defined the No-action Alternative as the choice by the applicants to continue the hatchery programs without ESA authorization and to potentially change hatchery production levels at any time. The three new FRF programs would produce up to 1,550,000 juveniles. Up to 13,993,000 salmon and steelhead juveniles would be released from the 10 hatchery programs annually (Table S-2). No new environmental protection or enhancement measures would be implemented.

Table S-2. Maximum annual hatchery releases of juvenile salmon and steelhead in the Duwamish-Green River Basin under the alternatives.

| Species | Alternative 1 (No Action) | Alternative 2 (Proposed Action) | Alternative 3 (Termination) | Alternative 4 (Reduced Production) | Alternative 5 (Increased Production/ Preferred Alternative) |
|---|---|---|---|---|---|
| Fall-run Chinook Salmon | 5,100,000 | 5,100,000 | 0 | 2,550,000 | 7,100,000 |
| Late Winter-run Steelhead | 383,000 | 383,000 | 0 | 191,500 | 305,000[1] |
| Summer-run Steelhead | 100,000 | 100,000 | 0 | 50,000 | 100,000 |
| Coho Salmon | 3,410,000 | 3,410,000 | 0 | 1,705,000 | 3,410,000 |
| Chum Salmon | 5,000,000 | 5,000,000 | 0 | 2,500,000 | 5,000,000 |
| **Total** | **13,993,000** | **13,993,000** | **0** | **6,996,500** | **15,915,000** |

Sources: HGMPs (Muckleshoot Indian Tribe 2014a, 2014b, 2014c, 2014d; Muckleshoot Indian Tribe and Suquamish Tribe 2017; Muckleshoot Indian Tribe et al. 2019; WDFW 2013, 2014a, 2014b, 2014c, 2015, 2017; James Scott, WDFW, email sent to Charlene Hurst, NMFS, June 21, 2018, regarding clarification on release number for the Soos Creek fall-run Chinook salmon program; Schaffler 2019)

[1] During the public comment period for the draft EIS, a revised HGMP for the Green River late winter-run steelhead program was submitted (WDFW 2017), proposing to release an additional 22,000 steelhead yearlings. After publication of the draft supplemental EIS, the FRF late winter-run steelhead program was changed from 350,000 to 250,000 yearlings, decreasing the total release level for steelhead by 78,000 yearlings, as referenced in the project biological opinion (NMFS 2019). Alternative 5 includes an analysis of these changes in steelhead yearling release levels.

**Alternative 2 (Proposed Action)**

This alternative consists of hatchery operations as proposed under the co-managers' HGMPs. NMFS would make a determination that the HGMPs submitted by the co-managers meet requirements of the 4(d) Rule. The salmon and steelhead hatchery programs in the Duwamish-Green River Basin would be implemented as described in the 10 submitted HGMPs (Table S-2), and, as under Alternative 1, up to 13,993,000 salmon and steelhead juveniles would be released annually. The hatchery programs would use hatchery capacity as described in the HGMPs for operations, and they would be adaptively managed over time to incorporate best management practices as new information is available.

**Alternative 3 (Termination)**

Under this alternative, NMFS would make a determination that the HGMPs as proposed do not meet the standards prescribed under Limit 5 and Limit 6 of the 4(d) Rule, and the 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin would be terminated. All salmon and steelhead being raised in hatchery facilities (i.e., fall-run Chinook salmon, late winter-run steelhead, summer-run steelhead, coho salmon, and chum salmon) would be released or killed, and no broodstock would be collected.

NMFS' regulations under the 4(d) Rule do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs submitted as an RMP. NMFS' regulations under the 4(d) Rule require NMFS to make a determination that the HGMPs submitted as an RMP *as proposed* either meet or do not meet the standards prescribed in the rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.

**Alternative 4 (Reduced Production)**

Under this alternative, the applicants would reduce the number of fish released from each of the 10 proposed hatchery programs by 50 percent (to 6,996,500 salmon and steelhead juveniles) because it represents a mid-point between the Proposed Action (Alternative 2) and termination of the hatchery programs (Alternative 3) (Table S-2). Revised HGMPs would be submitted reflecting these reduced production levels, and NMFS would make a determination that the revised HGMPs submitted as an RMP meet the requirements of the 4(d) Rule.

NMFS' regulations under the 4(d) Rule do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs submitted as an RMP. NMFS' regulations under the 4(d) Rule require NMFS to make a determination that the HGMPs submitted as an RMP *as proposed* either meet or do not meet the standards prescribed in the rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.

**Alternative 5 (Increased Production/Preferred Alternative)**

Under this alternative, the applicants would use existing facility capacity to increase the number of fall-run Chinook salmon subyearlings produced by the Soos Creek fall-run Chinook salmon hatchery program. The number of Soos Creek fall-run Chinook salmon subyearlings produced would be 6,200,000 fish, which is 2,000,000 more subyearlings than under Alternative 1 and Alternative 2 as

described in the draft EIS. Furthermore, the 2,000,000 subyearlings would be released from Palmer Pond, in addition to the 1,000,000 subyearlings that would be released from Palmer Pond under Alternative 1 and Alternative 2 as described in the draft EIS. Under Alternative 5, the total maximum release level would be 15,915,000 hatchery-origin salmon and steelhead as shown in Table S-2. Alternative 5 also includes changes in steelhead release levels. The Green River late winter-run steelhead hatchery program would increase by 22,000 yearlings to 55,000, and the FRF late winter-run steelhead hatchery program would decrease by 100,000 yearlings to 250,000, resulting in a net decrease of 78,000 steelhead yearlings as compared to Alternative 1 and Alternative 2.

Alternative 5 includes terms and conditions as described in the project's biological opinion (NMFS 2019) that would decrease hatchery effects on natural-origin Chinook salmon and steelhead.

A summary of distinguishing features of the alternatives is shown in Table S-3.

Table S-3. Summary of distinguishing features of the alternatives.

| Alternative | NMFS Review, Evaluation, and Approval of Plans under the 4(d) Rule | Number of Hatchery-origin Fish Released | Changes in Hatchery Programs | Conservation Benefit to Salmon and Steelhead |
|---|---|---|---|---|
| Alternative 1 (No Action) | No evaluation and determination under the 4(d) Rule | 13,993,000 | Similar to existing conditions, except that three new FRF programs would be implemented. Hatchery programs would not be exempt from ESA section 9 take prohibitions. No new environmental protection or enhancement measures would be implemented. | Conservation requirements for listed salmon and steelhead would not be met. |
| Alternative 2 (Proposed Action) | Evaluation and determination under the 4(d) Rule | 13,993,000 | Production levels would continue, with existing HGMP conservation measures that would be applied to salmon and steelhead hatchery programs to reduce risks and to meet conservation requirements. | Conservation requirements for listed salmon and steelhead would not be met[1]. |
| Alternative 3 (Termination) | Not applicable | 0 | Hatchery-origin salmon and steelhead programs would be terminated. | Conservation requirements for listed salmon and steelhead would be met, and most risks from hatchery programs would be eliminated over time. |
| Alternative 4 (Reduced Production) | Same as Alternative 2 | 6,996,500 | Releases of hatchery-origin salmon and steelhead would be reduced 50 percent compared to Alternative 1 and Alternative 2. | Conservation requirements for listed salmon and steelhead would not be met[1]. |
| Alternative 5 (Increased Production/ Preferred Alternative) | Same as Alternative 2 | 15,915,000 | Total production levels would increase compared to Alternative 1 and Alternative 2, and conservation measures as described in the biological opinion would be applied to salmon and steelhead hatchery programs to reduce risks and to meet conservation requirements. | Conservation requirements for listed salmon and steelhead would be met. |

[1] As evaluated in this EIS, Alternative 2 and Alternative 4 do not include the terms and conditions described under the project's biological opinion (NMFS 2019) that would ensure conservation for listed species. However, the existing HGMPs could be changed under Alternative 2 and Alternative 4 to include the biological opinion's terms and conditions so that the conservation measures would be met.

**Summary of Resource Effects**

Table S-4 provides a summary of the predicted resource effects under each of the five alternatives. The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences.

The relative magnitude and direction of impacts is described in Table S-4 using the following terms:

| | |
|---|---|
| Undetectable: | The impact would not be detectable. |
| Negligible: | The impact would be at the lower levels of detection, and could be either positive or negative. |
| Low: | The impact would be slight, but detectable, and could be either positive or negative. |
| Moderate: | The impact would be readily apparent, and could be either positive or negative. |
| High: | The impact would be greatly positive or severely negative. |

Positive or negative effects under existing conditions are relative to effects of no hatchery releases, whereas positive or negative effects under Alternative 1 are compared to existing conditions and effects under the other alternatives are compared to Alternative 1.

Table S-4. Summary of environmental consequences for EIS alternatives by resource.

| **Resource** | **Alternative 1 (No Action)** | **Alternative 2[1] (Proposed Action)** | **Alternative 3[1] (Termination)** | **Alternative 4[1] (Reduced Production)** | **Alternative 5[1] (Increased Production/ Preferred Alternative)** |
|---|---|---|---|---|---|
| Water Quantity and Quality | The hatchery programs would have a low negative effect on water quantity, primarily because water use would generally be non-consumptive and limited by water right permits, and because all surface water diverted would be returned near the points of withdrawal after it circulates through the hatchery facilities. | Same as Alternative 1. | Effects on water quantity would be the same as Alternative 1, because although the proposed salmon and steelhead programs would be terminated, the operators would exercise their water rights for the hatchery facilities. | Although hatchery production would be reduced 50 percent, effects on water quantity would be the same as Alternative 1. | Same as Alternative 1. |
| | The hatchery programs would have a negligible negative effect on water quality primarily because hatchery operations would be limited by National Pollutant Discharge Elimination System (NPDES) permits and would not be expected to contribute substantially to water quality impairments in the river basin. | Same as Alternative 1. | The hatchery programs would have a negligible positive effect on water quality due to salmon and steelhead production because the proposed hatchery programs would be terminated. | Although hatchery production would be reduced 50 percent, effects on water quality would be the same as Alternative 1. | Same as Alternative 1. |

Table S-4. Summary of environmental consequences for EIS alternatives for each resource, continued.

| Resource | Alternative 1 (No Action) | Alternative 2[1] (Proposed Action) | Alternative 3[1] (Termination) | Alternative 4[1] (Reduced Production) | Alternative 5[1] (Increased Production/ Preferred Alternative) |
|---|---|---|---|---|---|
| Salmon and Steelhead | The hatchery programs would generally have negligible to high negative genetics, competition, predation, facility operations, masking, incidental fishing, and disease transfer effects; and negligible to moderate positive population viability and nutrient cycling effects depending on the affected species. | Same as Alternative 1. | Because the hatchery programs would be terminated, all negative and positive effects on salmon and steelhead would be eliminated. | Because hatchery production would be reduced 50 percent, the negative genetics, competition, predation, facility operations, masking, incidental fishing, and disease transfer effects and the positive population viability and nutrient cycling effects would be reduced compared to Alternative 1. | The hatchery programs would range from negligible to high negative genetics, competition, predation, facility operations, masking, incidental fishing, and disease transfer effects; and negligible to moderate positive population viability and nutrient cycling effects depending on the affected species, which would be the same or vary compared to Alternative 1. The negative effects would be reduced compared to Alternative 1 due to additional terms and conditions incorporated into Alternative 5. |

Table S-4. Summary of environmental consequences for EIS alternatives for each resource, continued.

| Resource | Alternative 1 (No Action) | Alternative 2[1] (Proposed Action) | Alternative 3[1] (Termination) | Alternative 4[1] (Reduced Production) | Alternative 5[1] (Increased Production/ Preferred Alternative) |
|---|---|---|---|---|---|
| Other Fish Species | The hatchery programs would have negligible negative or negligible positive effects on other fish species, depending on whether the hatchery-origin fish compete with or prey on the other fish species. | Same as Alternative 1. | Because the hatchery programs would be terminated, all negative and positive effects on other fish species as competitors and predators would be eliminated. | Same as Alternative 1 because hatchery production would be reduced 50 percent and the negative effects on other fish species that compete with hatchery-origin fish and the positive effects on other fish species that benefit from hatchery-origin fish as a food source would be reduced. | Same as Alternative 1. |
| Wildlife – Southern Resident Killer Whale, Steller Sea Lion, California Sea Lion, Harbor Seal | The hatchery programs would have a low positive effect on Southern Resident killer whales and negligible positive effect on Steller sea lions, California sea lions, and harbor seals by providing a source of prey. | Same as Alternative 1. | Because the hatchery programs would be terminated, there would be a low negative effect on Southern Resident killer whales and a negligible negative effect on Steller sea lions, California sea lions, and harbor seals because a source of prey would be eliminated. | Because hatchery production would be reduced 50 percent, there would be a negligible positive effect on Southern Resident killer whales, Steller sea lions, California sea lions, and harbor seals but this positive effect would likely be lower than for Alternative 1 for Southern Resident killer whales. | The hatchery programs would have a moderate positive effect by providing an increased source of prey for Southern Resident killer whales and a negligible positive effect on Steller sea lions, California sea lions, and harbor seals compared to Alternative 1, and effects would be greater than under Alternative 1 for Southern Resident killer whales. |

Table S-4. Summary of environmental consequences for EIS alternatives for each resource, continued.

| Resource | Alternative 1 (No Action) | Alternative 2[1] (Proposed Action) | Alternative 3[1] (Termination) | Alternative 4[1] (Reduced Production) | Alternative 5[1] (Increased Production/ Preferred Alternative) |
|---|---|---|---|---|---|
| Socioeconomics | The hatchery programs would have a low positive effect on socioeconomics because personal income and jobs from tribal commercial and non-tribal recreational fisheries, income associated with hatchery operations, and contributions to the local and regional economies, would accrue primarily in King County in the South Puget Sound subregion. In addition, the economic activity and fisheries effects from the hatchery programs would have a relatively small impact on the overall economy of King County and Puget Sound. In some of the more remote areas of the river basin and the South Puget Sound subregion more economically dependent on income derived from the hatchery programs, effects would likely be greater. | Same as Alternative 1. | Because the hatchery programs would be terminated, there would be a low negative effect on socioeconomics because all commercial and recreational fishing, jobs, and personal income associated with the hatchery programs would be eliminated. | The hatchery programs would have a negligible positive effect on socioeconomics, because hatchery production would be reduced 50 percent, resulting in fewer returning adults to be harvested in commercial and recreational fisheries, and contributions to regional and local economies would be less relative to Alternative 1. | Same as Alternative 1. |

Table S-4. Summary of environmental consequences for EIS alternatives for each resource, continued.

| Resource | Alternative 1 (No Action) | Alternative 2[1] (Proposed Action) | Alternative 3[1] (Termination) | Alternative 4[1] (Reduced Production) | Alternative 5[1] (Increased Production/ Preferred Alternative) |
|---|---|---|---|---|---|
| Environmental Justice | The hatchery programs would have a moderate positive effect on environmental justice, primarily because of their economic impact on communities of concern (King County and the South Puget Sound subregion) and benefits to Native American tribes of concern from fishing for ceremonial and subsistence and commercial purposes. | Same as Alternative 1. | Because the hatchery programs would be terminated, there would be a moderate negative effect on environmental justice because all commercial and recreational fishing in communities of concern associated with the hatchery programs would be eliminated. Tribal ceremonial and subsistence fishing would continue. | Because hatchery production would be reduced 50 percent, the hatchery programs would have a low positive effect on user groups of concern (commercial fishermen) and Native American tribes of concern from fishing for ceremonial and subsistence and commercial purposes. | Same as Alternative 1. |
| Human Health | The hatchery programs would have a negligible negative effect on human health, primarily because the hatchery programs comply with worker safety programs, rules, and regulations; the use of therapeutics would be minimal and in compliance with label requirements; and personal protective equipment would be used that limits the spread of pathogens. | Same as Alternative 1. | Because the hatchery programs would be terminated, there would be a negligible positive effect on human health. | Although hatchery production would be reduced 50 percent, human health effects would be the same as Alternative 1. | Same as Alternative 1. |

[1] Differences between the no-action and the action alternatives are due to differences in the number of hatchery-origin fish produced.

**Summary of Major Changes Made in Response to Public Comments on the Draft EIS and Draft Supplemental EIS**

Below is a summary of major changes made to the final EIS. Changes were also made for editorial reasons, for purposes of clarification, to correct unsubstantial computation or transcription errors, or to provide more recent information, and these are not shown in the list. The locations of major text modifications are denoted by chapter.

**Summary:**

1. Identified Alternative 5 (Increased Production) as the Preferred Alternative and updated the summary of effects
2. Added information regarding Alternative 5

**Chapter 1:**

1. In the discussion of purpose and need, added the co-managers' desire to help provide additional Chinook salmon as prey for Southern Resident killer whales
2. Added information on public review and comments received on the draft EIS and draft supplemental EIS
3. Added information regarding Alternative 5

**Chapter 2:**

1. Added more clarifying information on Alternative 1 and alternatives considered but not analyzed in detail
2. Added information identifying the Preferred Alternative
3. Added information describing Alternative 5

**Chapter 3:**

1. Added information on effects of predation on natural-origin Chinook salmon to help inform the analysis of predation effects in Chapter 4, Environmental Consequences
2. Added information on genetic exchange and effects between hatchery-origin and natural-origin salmon and steelhead
3. Added information regarding Southern Resident killer whales', Steller sea lions', California sea lions', and harbor seals' preferred prey, including salmon and steelhead, to help inform the analysis of effects on Southern Resident killer whales in Chapter 4, Environmental Consequences

**Chapter 4:**

1. Added information regarding hatchery production and terms and conditions specific to Alternative 5 for all resource areas
2. Revised the proposed FRF hatchery production so that the analysis of effects on each resource area is based only on release of juvenile salmon and steelhead below Howard Hanson Dam
3. Added information clarifying genetic effects on natural-origin Chinook salmon and steelhead and predation effects on natural-origin Chinook salmon
4. Revised information about hatchery production effects on Southern Resident killer whales based on recent information
5. Added information about hatchery production effects on Steller sea lions, California sea lions, and harbor seals
6. Slightly changed the methodology for determining jobs and personal income associated with hatchery operations, resulting in unsubstantial changes to Alternative 1 (No Action), Alternative 2 (Proposed Action), Alternative 3 (Termination), and Alternative 4 (Reduced Production) compared to the draft EIS
7. Revised information on Environmental Justice effects under Alternative 4, Reduced Production

**Chapter 5:**

1. Added information on the Southern Resident killer whale's competitors (Steller sea lions, California sea lions, and harbor seals) and Washington Governor Jay Inslee's Executive Order 18-02 specific to the Southern Resident killer whale

**Appendices:**

1. Revised Appendix A to reflect hatchery production levels under Alternative 5
2. Revised Appendix B to remove evaluation of the FRF program scenario to release juvenile salmon and steelhead above Howard Hanson Dam
3. Added Appendix C, which includes public comments on the draft EIS and draft supplemental EIS and NMFS' responses

# Table of Contents

# List of Tables

# List of Figures



# List of Appendices

THIS PAGE INTENTIONALLY LEFT BLANK

# Acronyms and Abbreviations

| | |
|---|---|
| 4(d) Rule | final rule pursuant to ESA section 4(d) |
| BMP | best management practice |
| BOD | biochemical oxygen demand |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| DAO | Departmental Administrative Order |
| DDT | dichlorodiphenyltrichloroethane |
| DGF | demographic gene flow |
| DNR | Washington Department of Natural Resources |
| DPS | distinct population segment |
| Ecology | Washington Department of Ecology |
| EIS | environmental impact statement |
| EPA | U.S. Environmental Protection Agency |
| ESA | Endangered Species Act |
| ESU | evolutionarily significant unit |
| FRAM | Fishery Regulation and Assessment Model |
| FRF | fish restoration facility |
| FTE | full-time equivalent |
| HCP | habitat conservation plan |
| HGMP | hatchery and genetic management plan |
| HSRG | Hatchery Scientific Review Group |
| HxN | hatchery-origin cross natural-origin |
| ISAB | Independent Scientific Advisory Board |
| MMPA | Marine Mammal Protection Act |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service (also called NOAA Fisheries Service) |
| NOAA | National Oceanic and Atmospheric Administration |

| | |
|---|---|
| NPDES | National Pollutant Discharge Elimination System |
| NWIFC | Northwest Indian Fisheries Commission |
| NWFSC | Northwest Fisheries Science Center |
| PCB | polychlorinated biphenyl |
| PEHC | proportionate effective hatchery contribution |
| PEPD | Pending Evaluation and Proposed Determination |
| pHOS | proportion of hatchery-origin spawners |
| PNI | proportionate natural influence |
| pNOB | proportion of natural-origin fish in the hatchery broodstock |
| PRA | population recovery approach |
| PSP | Puget Sound Partnership |
| PSRC | Puget Sound Regional Council |
| RCO | Washington Recreation and Conservation Office |
| RCW | Revised Code of Washington |
| RM | river mile |
| RMP | resource management plan |
| ROD | Record of Decision |
| Services | USFWS and NMFS |
| SIWG | Species Interaction Work Group |
| TPU | Tacoma Public Utilities |
| USACE | U.S. Army Corps of Engineers |
| USC | United States Code |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| VSP | viable salmonid population |
| WAC | Washington Administrative Code |
| WDFW | Washington Department of Fish and Wildlife |
| WRIA | water resource inventory area |

# Glossary of Key Terms

**4(d) Rule:** A special regulation developed by NMFS under authority of section 4(d) of the ESA, modifying the normal protective regulations for a particular threatened species when it is determined that such a rule is necessary and advisable to provide for the conservation of that species.

**Abundance:** Generally, the number of fish in a defined area or unit. It is also one of four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

**Adaptive management:** A deliberate process of using research, monitoring, and scientific evaluation when making decisions in the face of uncertainty.

**Acclimation pond:** A concrete or earthen pond or a temporary structure used for rearing and imprinting juvenile fish in the water of a particular stream before their release into that stream.

**Anadromous:** A term used to describe fish that hatch and rear in fresh water, migrate to the ocean to grow and mature, and return to fresh water to spawn.

**Analysis area:** Within this environmental impact statement (EIS), the analysis area is the geographic extent that is being evaluated for each resource. For some resources (e.g., socioeconomics and environmental justice), the analysis area is larger than the project area. See also **Project area**.

**Best management practice (BMP):** A policy, practice, procedure, or structure implemented to mitigate adverse environmental effects.

**Biological opinion:** Document stating the National Marine Fisheries Services' (NMFS') or the U.S. Fish and Wildlife Services' (USFWS') opinion as to how Federal agency actions affect ESA-listed species and critical habitat and whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

**Broodstock:** A group of sexually mature individuals of a species that is used for breeding purposes as the source for a subsequent generation.

**Catch areas:** Geographic areas defined by Washington State along the Pacific coast of Washington, Strait of Georgia, and Puget Sound that are used to report catch of fish and shellfish and determine specific regulations for fishing.

**Ceremonial and subsistence:** A phrase used to describe harvests by Puget Sound treaty tribes under their treaty-reserved fishing rights under *United States v. Washington*. Fish are used for tribal ceremonies and to meet the nutritional needs of tribal members.

**Co-managers:** Washington Department of Fish and Wildlife and Puget Sound treaty tribes, which are jointly responsible for managing fisheries and hatchery programs in the state of Washington.

**Commercial harvest:** The activity of catching fish for commercial profit.

**Conservation:** Used generally in this EIS as the act or instance of conserving or keeping fish resources from change, loss, or injury, and leading to their protection and preservation. This contrasts with the definition under the Federal Endangered Species Act (ESA), which refers to the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.

**Critical habitat:** A specific term and designation within the ESA referring to habitat area essential to the conservation of a listed species, though the area need not actually be occupied by the species at the time it is designated.

**Density dependence:** A term used in population ecology to describe how population growth rates are regulated by the density of a population. Usually, the denser a population is, the greater its mortality. Most density-dependent factors are biological in nature, such as predation and competition.

**Dewatering:** Typically, the immediate downstream habitat effects associated with a water withdrawal action that diverts the entire flow of a stream or river to another location.

**Distinct population segment (DPS):** Under the ESA, the term "species" includes any subspecies of fish or wildlife or plants, and any "distinct population segment" of any species or vertebrate fish or wildlife that interbreeds when mature. The ESA thus considers a DPS of vertebrates to be a "species." The ESA does not however establish how distinctness should be determined. Under NMFS policy for Pacific salmon, a population or group of populations will be considered a DPS if it represents an evolutionarily significant unit (ESU) of the biological species. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-USFWS Policy for recognizing DPSs (DPS Policy; 61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy but applies to a broader range of animals to include all vertebrates. See also **Evolutionarily significant unit**.

**Diversion:** A facility, dam, or weir to direct water and fish for use at a hatchery facility. A diversion usually involves a screen to keep fish from entering a water intake. See also **Water intake**.

**Diversity:** Variation at the level of individual genes (polymorphism); provides a mechanism for populations to adapt to their ever-changing environment. It is also one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

**Domestication:** See **Hatchery-influenced selection**.

**Endangered species:** As defined under the ESA, any species that is in danger of extinction throughout all or a significant portion of its range.

**Endangered Species Act (ESA):** A United States law that provides for the conservation of endangered and threatened species of fish, wildlife, and plants.

**Environmental justice:** The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

**Escapement:** Adult salmon and steelhead that survive fisheries and natural mortality and return to spawn.

**Estuary:** The area where fresh water of a river meets and mixes with the salt water of the ocean.

**Evolutionarily significant unit (ESU):** A concept NMFS uses to identify distinct population segments of Pacific salmon (but not steelhead) under the ESA. An ESU is a population or group of populations of Pacific salmon that 1) is substantially reproductively isolated from other populations, and 2) contributes substantially to the evolutionary legacy of the biological species. See also **Distinct Population Segment** (pertaining to steelhead).

**Federal Register:** The United States government's daily publication of Federal agency regulations and documents, including executive orders and documents that must be published per acts of Congress.

**Fingerling:** A juvenile fish.

**Fishery:** Harvest by a specific gear type in a specific geographical area during a specific time period.

**Fishway:** Any structure or modification to a natural or artificial structure to provide or enhance fish passage.

**Fitness:** As used in this EIS, the propensity of a group of fish (e.g., a population) to survive and reproduce.

**Forage fish:** Small fish that breed prolifically and serve as food for predatory fish.

**Fry:** Juvenile salmon and steelhead that are usually less than 1 year old and have absorbed their egg sac.

**Gene flow:** The genetic mechanism whereby genes are transferred from one population to another. See also **Introgression**.

**Habitat:** The physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal; the place where an organism naturally lives.

**Habitat conservation plan (HCP)**: A planning document required as part of an application for an incidental take permit for species listed under the ESA. An HCP describes the anticipated effects of the anticipated taking of a listed species resulting from otherwise lawful activities associated with a proposed action, how those impacts will be minimized or mitigated, and how the HCP is to be funded.

**Hatchery and genetic management plan (HGMP):** A technical document that describes the composition and operation of an individual hatchery program. Under Limit 5 of the 4(d) Rule, NMFS uses information in HGMPs to evaluate impacts on salmon and steelhead listed under the ESA. See also **Limit 5 and 6.**

**Hatchery facility:** A facility (e.g., hatchery, rearing pond, net pen) that supports one or more hatchery programs.

**Hatchery-influenced selection:** The process whereby genetic characteristics of hatchery populations become different from their source populations as a result of selection in hatchery environments (also referred to as domestication).

**Hatchery operator:** A Federal agency, state agency, or Native American tribe that operates a hatchery program.

**Hatchery-origin fish:** A fish that originated from a hatchery facility.

**Hatchery-origin spawner:** A hatchery-origin fish that spawns naturally.

**Hatchery program:** A program that artificially propagates fish. Most hatchery programs for salmon and steelhead spawn adults in captivity, raise the resulting progeny for a few months or longer, and then release the fish into the natural environment where they will mature.

**Hatchery Scientific Review Group (HSRG):** The independent scientific panel established and funded by Congress to provide an evaluation of hatchery reform in Puget Sound from 2000 to 2004.

**Hydropower:** Electrical power generation through use of gravitational force of falling water at dams.

**Incidental:** Unintentional, but not unexpected.

**Incidental fishing effects:** Fish, marine birds, or mammals unintentionally captured during fisheries using any of a variety of gear types.

**Integrated hatchery program:** A hatchery program that intends for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the natural environment. Differences between hatchery-origin and natural-origin fish are minimized, and hatchery-origin fish are integrated with the local populations included in an ESU or DPS.

**Introgression:** Gene flow from non-local hatchery-origin salmon and steelhead into natural-origin populations.

**Isolated hatchery program:** A hatchery program that intends for the hatchery-origin population to be reproductively segregated from the natural-origin population. These programs produce fish that are different from local populations. They do not contribute to conservation or recovery of populations included in an ESU or DPS.

**Limit 5 and 6:** Under section 4(d) of the ESA (see **4(d) Rule**), Limit 5 is a limit on "take" prohibitions that identifies specific criteria for state and federal hatchery plans, and Limit 6 identifies criteria that apply to joint state/tribal resource management plans developed under the *United States v. Washington* (1974) or *United States v. Oregon* (1969) proceedings.

**Limiting factor:** A physical, chemical, or biological feature that impedes species and their independent populations from reaching a viable status.

**National Environmental Policy Act (NEPA):** A United States environmental law that established national policy promoting the enhancement of the environment and established the President's Council on Environmental Quality (CEQ).

**National Marine Fisheries Service (NMFS):** A United States agency within the National Oceanic and Atmospheric Administration and under the Department of Commerce charged with the stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems.

**National Pollutant Discharge Elimination System (NPDES):** A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the U.S. Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation.

**Native fish:** Fish that are endemic to or limited to a specific region.

**Natural-origin:** A term used to describe fish that are offspring of parents that spawned in the natural environment rather than the hatchery environment, unless specifically explained otherwise in the text. "Naturally spawning" and similar terms refer to fish spawning in the natural environment.

**Net pen:** A fish rearing enclosure used in marine areas.

**Northwest Indian Fisheries Commission (NWIFC):** A support service organization to 20 treaty Indian tribes in western Washington, created following the *United States v. Washington* ruling, that assists member tribes in their role as natural resources co-managers.

**Outmigration:** The downstream migration of salmon and steelhead toward the ocean.

**Pathogen:** An infectious microorganism that can cause disease (e.g., virus, bacteria, fungus) in its host.

**Population:** A group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group.

**Population recovery approach (PRA):** A draft framework prepared by NMFS that categorizes listed Puget Sound Chinook salmon populations and the watersheds on which they depend into one of three tiers for ESA consultation and recovery planning purposes. Tier 1 populations are of primary importance for preservation, restoration, and ESU recovery and have to be viable for the ESU as a whole to meet viability criteria in the recovery plan for Puget Sound Chinook salmon. Tier 2 populations are less important for recovery to a low extinction risk status. Tier 3 populations are allowed to absorb more effects but would still require ESA protection so that the populations maintain a trajectory toward recovery, albeit over a longer term than for Tier 1 and Tier 2 populations.

**Preferred Alternative:** The alternative selected or developed from an evaluation of alternatives. Under NEPA, the Preferred Alternative is the alternative an agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

**Productivity:** The rate at which a population is able to produce reproductive offspring. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

**Project area:** Geographic area where the Proposed Action would take place. See also **Proposed Action** and **Analysis area**.

**Proportion of hatchery-origin spawners (pHOS):** The proportion of naturally spawning salmon or steelhead that are hatchery-origin fish.

**Proportion of natural-origin broodstock (pNOB):** The proportion of natural-origin broodstock that are incorporated into a hatchery program.

**Proportionate natural influence (PNI):** A measure of hatchery influence on natural populations that is a function of both the proportion of hatchery-origin spawners spawning in the natural environment (pHOS) and the proportion of natural-origin broodstock incorporated into the hatchery program (pNOB). PNI can also be thought of as the percentage of time all the genes of population collectively have spent in the natural environment.

**Proposed Action:** NMFS's review and approval under Limit 6 of the 4(d) Rule for 10 salmon and steelhead HGMPs (and hatchery releases) within the Duwamish-Green River Basin submitted as an RMP by the co-managers. See also **Limit 6** and **4(d) Rule**.

**Puget Sound treaty tribes:** Indian tribes in the project area with treaty fishing rights pursuant to *United States v. Washington*. For this EIS, the tribes are the Muckleshoot Indian Tribe and Suquamish Tribe.

**Rearing pond:** See **Acclimation Pond**.

**Record of Decision (ROD):** The formal NEPA decision document that is recorded for the public. It is announced in a Notice of Availability in the Federal Register.

**Recovery:** Defined in the ESA as the process by which the decline of an endangered or threatened species is stopped or reversed, or threats to its survival neutralized so that its long-term survival in the wild can be ensured and it can be removed from the list of threatened and endangered species.

**Recovery plan:** Under the ESA, a formal plan from NMFS (for listed salmon and steelhead) outlining the goals and objectives, management actions, likely costs, and estimated timeline to recover the listed species.

**Recreational harvest:** The activity of catching fish for non-commercial reasons (e.g., sport or recreation).

**Redd:** The spawning site or "nest" in stream and river gravels in which salmon and steelhead lay their eggs.

**Residuals:** Hatchery-origin fish that out-migrate slowly, if at all, after they are released. Residualism occurs when such fish residualize rather than out-migrate as most of their counterparts do.

**Resource management plan (RMP):** A plan that includes a process, management objectives, specific details, and other information required to manage a natural resource. For this EIS, the resources are salmon and steelhead hatchery programs in the Duwamish-Green River Basin.

**River basin:** The area drained by a river and its tributaries.

**Run:** The migration of salmon or steelhead from the ocean to fresh water to spawn. Defined by the season they return as adults to the mouths of the rivers from which they originated.

**Run size:** The number of adult salmon or steelhead (i.e., harvest plus escapement) returning to the rivers from which they originated. See also **Total Return**.

**Scoping:** In NEPA, an early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

**Section 7 consultation:** Federal agency consultation with NMFS or USFWS (dependent on agency jurisdiction) on any actions that may affect listed species, as required under section 7 of the ESA.

**Section 10 permit:** A permit for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species. Issued by NMFS or USFWS (dependent on agency jurisdiction) as authorized under section 10(a)(1)(A) of the ESA.

**Smolts:** Juvenile salmon and steelhead that have left the streams from which they originated, are out-migrating downstream, and are physiologically adapting to live in salt water.

**Smoltification:** The process of physiological change that juvenile salmon and steelhead undergo in fresh water while out-migrating to salt water that allow them to live in the ocean.

**Spatial structure:** The spatial structure of a population refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

**Stock:** A group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place in a different season.

**Straying (of hatchery-origin fish):** A term used to describe when hatchery-origin fish return to and/or spawn in areas where they are not intended to return/spawn.

**Subyearling:** Juvenile salmon less than 1 year of age.

**Supplementation:** Release of fish into the natural environment to increase the abundance of naturally reproducing fish populations.

**Take:** Under the ESA, the term "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Take for hatchery activities includes, for example, the collection of listed fish (adults and juveniles) for hatchery broodstock, the collection of listed hatchery-origin fish to prevent them from spawning naturally, and the collection of listed fish (juvenile and adult fish) for scientific purposes.

**Threat:** A human action or natural event that causes or contributes to limiting factors; threats may be caused by past, present, or future actions or events. See also **Limiting factor**.

**Threatened species:** As defined by section 4 of the ESA, any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

**Total return:** The number of adult salmon or steelhead (i.e., harvest plus escapement) returning to the streams from which they originated. See also **Run size**.

**Tributary:** A stream or river that flows into a larger stream or river.

**Viability:** As used in this EIS, a measure of the status of listed salmon and steelhead populations that uses four criteria: abundance, productivity, spatial distribution, and diversity.

**Viable salmonid population (VSP):** An independent population of salmon or steelhead that has a negligible risk of extinction over a 100-year timeframe (McElhany et al. 2000).

**Volitional:** A term used to describe the method of passively releasing fish that allows fish to leave hatchery facilities when the fish are ready.

**Water right:** A legal authorization to divert or withdraw some portion of the public waters of the state (surface water or groundwater) for a beneficial purpose, subject to the specific terms and conditions of a water right permit, certificate, or claim. A certificate is issued by Washington State as the official legal record of the water right when it has confirmed that the water has been put to beneficial use

according to terms and conditions of the permit. Once a water right has been put to beneficial use, the water must continue to be used or the holder will face possible loss of all or a portion of the right through abandonment or relinquishment.

**Water intake:** Structure used to access water from a stream for use at hatchery facilities. A water intake usually involves some form of screen to prevent salmon and steelhead from entering the intake. See also **Diversion.**

**Watershed:** An area of land or catchment where all the water that is under it or drains off of it goes into the same place.

**Weir:** An adjustable dam placed across a river to regulate the flow of water downstream; a fence placed across a river to catch fish.

**Water resource inventory area (WRIA):** A system for delineating watersheds used by Washington State.

**Yearling:** Juvenile salmon or steelhead that has reared at least 1 year in a hatchery.

# Chapter 1

# 1 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

## 1.1. Background

### 1.1.1 Administering the Endangered Species Act

The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Federal Endangered Species Act (ESA) as it relates to listed salmon and steelhead. Actions that may affect listed species are reviewed by NMFS under section 7 or section 10 of the ESA or under section 4(d), which can be used to limit the application of take prohibitions described in section 9. On June 19, 2000, NMFS issued a final rule pursuant to ESA section 4(d) (4(d) Rule), adopting regulations necessary and advisable to conserve threatened species (50 Code of Federal Regulations [CFR] 223.203). The 4(d) Rule applies the take prohibitions in section 9(a)(1) of the ESA to salmon and steelhead listed as threatened, and also sets forth specific circumstances when the prohibitions will not apply, known as 4(d) limits. With regard to hatchery programs (Box 1-1) that meet the substantive requirements for hatchery and genetic management plans (HGMPs) described under Limit 5 of the 4(d) Rule, and where such hatchery programs are jointly submitted by tribal and state governments and meet the substantive requirements for hatchery or fishery resource management plans (RMPs) under Limit 6[1] of the 4(d) Rule, NMFS declared that section 9 take prohibitions would not apply (Subsection 1.5.3, NMFS' Determination as to Compliance with the 4(d) Rule).

[1] The 4(d) Rule prohibits the take of listed threatened salmon or steelhead, except in cases where the take is associated with an approved program. The 4(d) Rule includes a set of 13 limits (including Limit 5 and Limit 6 regarding hatcheries) on the application of ESA take prohibitions for specific categories of activities that adequately limit the adverse impacts of those activities. Limit 5 identifies specific criteria for state and federal HGMPs, whereas Limit 6 identifies criteria for joint tribal/state RMPs developed under the *United States v. Washington* (1974) or *United States v. Oregon* (1969) court proceedings.

**Box 1-1. What are hatchery and genetic management plans and hatchery resource management plans? What are the differences between hatchery programs and hatchery facilities?**

**Hatchery and Genetic Management Plans –** Hatchery and genetic management plans, or HGMPs, are specific to the ESA and are outlined under Limit 5 of the 4(d) Rule. They are the plans that describe hatchery programs and reflect the fish species propagated, the main hatchery facility used, the life stage when the fish are released, and the location of fish releases. In general, several hatchery programs and their associated HGMPs may be associated with each primary hatchery facility. For example, the Soos Creek Hatchery facilities support fall-run Chinook salmon, summer-run steelhead, and coho salmon programs described in three HGMPs (Table 1 and Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities).

**Resource Management Plans –** Resource management plans, or RMPs, are also specific to the ESA and are outlined under Limit 6 of the 4(d) Rule. They can pertain to fishery management plans or hatchery management plans. HGMPs can serve as RMPs for hatchery programs. RMPs are jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and Puget Sound treaty tribes under *United States v. Washington* (1974) court proceedings. The plans may encompass tribal, state, and Federal hatchery programs and facilities, which often operate in the same watersheds, exchange eggs, and share rearing space to maximize effectiveness.

**Hatchery Programs and Facilities –** Hatchery programs are defined by how the artificial production for individual species at facilities are managed and operated. Hatchery facilities are defined by the physical structures required for artificial production (e.g., hatchery buildings, adult holding or juvenile rearing ponds).

### 1.1.2 Hatchery and Genetic Management Plan Submittal

The Washington Department of Fish and Wildlife (WDFW), Muckleshoot Indian Tribe, and Suquamish Tribe, as co-managers of the fisheries resource under *United States v. Washington,* 384 F. Supp. 312 (W.D. Wash 1974) (hereafter referred to as "the co-managers") (Box 1-2), have provided NMFS with 10 HGMPs describing 10 hatchery programs for fall-run Chinook salmon, late winter-run steelhead, summer-run steelhead, coho salmon, fall-run chum salmon, and associated monitoring and evaluation actions in the Duwamish-Green River Basin that affect ESA-listed Puget Sound Chinook salmon and Puget Sound steelhead (Table 1). The HGMPs provide the frameworks through which the

Washington State and tribal jurisdictions propose to jointly and adaptively manage hatchery operations, monitoring, and evaluation activities, while meeting requirements specified under the ESA.

**Box 1-2. What is *United States v. Washington*, and what does it do?**

*United States v. Washington* is the 1974 Federal court proceeding that enforces and implements treaty fishing rights for salmon and steelhead (and other species) returning to Puget Sound (and other areas). Fishing rights and access to fishing areas in Puget Sound were reserved in treaties that the Federal government signed with the tribes in the 1850s. Under *United States v. Washington*, the Puget Sound Salmon Management Plan is the implementation framework for the allocation, conservation, and equitable sharing principles defined in *United States v. Washington* that governs the joint management of harvest of salmon and steelhead resources between the Puget Sound treaty tribes and State of Washington. The joint hatchery RMP reviewed in this EIS, and joint harvest RMPs such as the Puget Sound Chinook harvest management plan, are components of the Puget Sound Salmon Management Plan.

Table 1. HGMPs describing 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin.

| Hatchery Program | Primary Facilities | Operator |
|---|---|---|
| Soos Creek fall-run Chinook salmon[1] | Soos Creek Hatchery<br>Icy Creek Pond<br>Palmer Pond | WDFW |
| FRF fall-run Chinook salmon[1] | FRF<br>Palmer Pond | Muckleshoot Indian Tribe |
| Green River late winter-run steelhead[1] | Soos Creek Hatchery<br>Icy Creek Pond<br>Flaming Geyser Pond<br>Palmer Pond | WDFW |
| FRF late winter-run steelhead[1] | FRF | Muckleshoot Indian Tribe |
| Soos Creek summer-run steelhead | Soos Creek Hatchery<br>Icy Creek Pond | WDFW |
| Soos Creek coho salmon | Soos Creek Hatchery<br>Miller Creek Hatchery<br>Des Moines Marina Net Pens | WDFW |
| Keta Creek coho salmon | Soos Creek Hatchery (a source of subyearlings)<br>Keta Creek Complex<br>Elliott Bay Net Pens | Muckleshoot Indian Tribe and Suquamish Tribe |
| Marine Technology Center coho salmon | Marine Technology Center<br>Soos Creek Hatchery (a source of eggs) | WDFW |
| FRF coho salmon | FRF | Muckleshoot Indian Tribe |
| Keta Creek chum salmon | Keta Creek Complex | Muckleshoot Indian Tribe |

Sources: Muckleshoot Indian Tribe 2014a, 2014b, 2014c, 2014d; Muckleshoot Indian Tribe and Suquamish Tribe 2017; Muckleshoot Indian Tribe et al. 2019; WDFW 2013, 2014a, 2014b, 2014c, 2015, 2017; James Scott, WDFW, email sent to Charlene Hurst, NMFS, June 21, 2018, regarding clarification on release number for the Soos Creek fall-run Chinook salmon program; Schaffler 2019

[1] Hatchery-origin fish produced by the program are listed as threatened under the ESA.

During the public comment period for the draft environmental impact statement (EIS), WDFW submitted an updated HGMP for the Green River late winter-run steelhead program. The updated HGMP is similar to the original HGMP that was submitted to NMFS and analyzed in the draft EIS. Compared to the original HGMP, the updated HGMP increases the production level by 22,000 steelhead, from 33,000 to 55,000 yearlings. Further, from NMFS's review of the HGMPs for its

biological opinion (NMFS 2019), NMFS and the co-managers agreed that the fish restoration facility (FRF) late winter-run steelhead program production level would be decreased by 100,000 steelhead, from 350,000 to 250,000 yearlings to reduce the program's effect on natural-origin steelhead. Thus, the net decrease in proposed steelhead production levels for the late winter-run steelhead programs is 78,000 yearlings. These changes proposed by the updated HGMP and biological opinion are evaluated in this final EIS under Alternative 5.

The co-managers developed the plans jointly, and have provided the HGMPs for review and determination by NMFS as to whether they address the criteria under Limit 6 of the 4(d) Rule, using the specific criteria for hatchery programs under Limit 5 of the 4(d) Rule. For the purposes of the proposed recommendation, NMFS considers the 10 joint HGMPs, submitted for consideration under Limit 6, to be an RMP. For more information on the 4(d) Rule, see Subsection 1.5.3, NMFS' Determination as to Compliance with the 4(d) Rule.

### 1.1.3 Related National Environmental Policy Act Reviews

NMFS conducted a previous National Environmental Policy Act (NEPA) analysis relevant to this EIS, specifically, a draft EIS reviewing two RMPs and appended HGMPs for Puget Sound salmon and steelhead hatcheries (i.e., Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs – herein referred to as the PS Hatcheries DEIS [NMFS 2014a]) (79 Fed. Reg. 43465, July 25, 2014), subsequently terminated (80 Fed. Reg. 15986, March 26, 2015). As discussed in the Federal Register Notice terminating the preparation of a single EIS and review under the 4(d) Rule of two RMPs and appended HGMPs for hatchery programs in the Puget Sound Basin, NMFS determined that, following the public comment period on the PS Hatcheries DEIS (NMFS 2014a), reviews under NEPA and the 4(d) Rule organized around smaller numbers of HGMPs would allow for more detailed analyses of potential effects of individual HGMPs than the scope of review in the PS Hatcheries DEIS (NMFS 2014a). Additionally, analyses of all hatchery programs in the Puget Sound Basin under one NEPA review is not necessary to fully consider effects of those programs. Although currently over 100 salmon and steelhead hatchery programs operate in the Puget Sound Basin (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities), they have different operators (e.g., state and tribal), they do not rely on each other for their operation or justification, and updated HGMPs/RMPs for these programs either have recently been or are expected to be submitted by the co-managers to NMFS for approval, generally on a watershed-specific basis. The combined effects of all hatchery programs within the Puget Sound Basin are addressed in this EIS in Chapter 5, Cumulative Effects.

The 10 HGMPs grouped into this EIS review were organized in this way because all 10 hatchery programs pertain to salmon and steelhead hatchery programs that occur in the Duwamish-Green River Basin and would affect similar resources.

This EIS incorporates information by reference from the PS Hatcheries DEIS (NMFS 2014a), including detailed discussions on the ESA (PS Hatcheries DEIS, Subsection 1.1.1, The Endangered Species Act), take of listed species with specific information related to Puget Sound Hatchery RMPs and HGMPs, and background on the use of hatcheries in Puget Sound (PS Hatcheries DEIS, Subsection 1.1.2, Take of a Listed Species). Information incorporated by reference from the PS Hatcheries DEIS (NMFS 2014a) is summarized within various subsections of this EIS.

## 1.2 Description of the Proposed Action

Under the Proposed Action, NMFS would determine whether the HGMPs submitted as an RMP meet the requirements of Limit 6 of the 4(d) Rule. Activities included in the HGMPs generally are as follows:

- Broodstock collection through operation of weirs, fish traps, and adult collection ponds (Table 2)
- Holding, identification, and spawning of adult fish at Soos Creek Hatchery, Keta Creek Complex, Marine Technology Center, Icy Creek Pond, and at a new FRF (Table 2)
- Egg incubation at Soos Creek Hatchery, Keta Creek Hatchery, Marine Technology Center, Icy Creek Pond, and at a new FRF (Table 2)
- Fish rearing at Soos Creek Hatchery, Icy Creek Pond, Palmer Pond, an FRF at Green River (river mile [RM] 60), Miller Creek Hatchery, Des Moines Net Pens, Elliott Bay Net Pens, Keta Creek Complex, Marine Technology Center, and Flaming Geyser Pond (Table 2)
- Release of fall-run Chinook salmon, steelhead, coho salmon, and chum salmon into the Duwamish-Green River Basin (Table 2)
- Removal of adult hatchery-origin salmon and steelhead returning to the Duwamish-Green River Basin at weirs, fish traps, and other collection facilities
- Monitoring and evaluation activities to assess the performance of the hatchery programs in meeting conservation, harvest augmentation, and listed fish risk minimization objectives (Table 2)

Table 2. Hatchery facilities, locations, and activities associated with 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin. All programs use facilities that exist under current conditions and are operated under current conditions, except for the three FRF hatchery programs.

| Hatchery Program | Facility | Location | Broodstock Collection | Spawning Facilities | Incubation Facilities | Rearing Facilities | Juvenile Fish Release | Monitoring and Evaluation |
|---|---|---|---|---|---|---|---|---|
| Soos Creek fall-run Chinook salmon | Soos Creek Hatchery | Big Soos Creek (water resource inventory area [WRIA] 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Icy Creek Pond | Icy Creek (WRIA 09.0125), tributary to the Green River (WRIA 09.0001) at RM 48.3 | | | | ✓ | ✓ | ✓ |
| | Palmer Pond | Unnamed stream (WRIA 09.0147) at RM 0.2, tributary to the Green River (WRIA 09.0001) at RM 56.1 | | | | ✓ | ✓ | ✓ |
| | Tacoma Water Headworks | Green River (WRIA 09.0001) at RM 61 | ✓ | | | | | ✓ |
| FRF fall-run Chinook salmon | Soos Creek Hatchery | Big Soos Creek (WRIA 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | | | | ✓ | ✓ |
| | Palmer Pond | Unnamed stream (WRIA 09.0147) at RM 0.2, tributary to the Green River (WRIA 09.0001) at RM 56.1 | ✓ | | | | ✓ | ✓ |
| | FRF | Green River (WRIA 09.0001) at RM 60 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Tacoma Water Headworks | Green River (WRIA 09.0001) at RM 61 | ✓ | | | | | ✓ |
| Green River late winter-run steelhead | Soos Creek Hatchery | Big Soos Creek (WRIA 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | ✓ | ✓ | | | ✓ |
| | Icy Creek Pond | Icy Creek (WRIA 09.0125) tributary to the Green River (WRIA 09.0001) at RM 48.3 | ✓ | | | ✓ | ✓ | ✓ |
| | Flaming Geyser Pond | Cristy Creek (WRIA 09.0038) at RM 0.1, tributary to the Green River (WRIA 09.0001) at RM 44.3 | | | | ✓ | ✓ | ✓ |
| | Palmer Pond | Unnamed stream (WRIA 09.0147) at RM 0.2, tributary to the Green River (WRIA 09.0001) at RM 56.1 | | | | ✓ | ✓ | ✓ |

Table 2. Hatchery facilities, locations, and activities associated with 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin. All programs use facilities that exist under current conditions and are operated under current conditions, except for the three FRF hatchery programs, continued.

| Hatchery Program | Facility | Location | Broodstock Collection | Spawning Facilities | Incubation Facilities | Rearing Facilities | Juvenile Fish Release | Monitoring and Evaluation |
|---|---|---|---|---|---|---|---|---|
| FRF late winter-run steelhead | FRF | Green River (WRIA 09.0001) at RM 60 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Tacoma Water Headworks | Green River (WRIA 09.0001) at RM 61 | ✓ | | | | | ✓ |
| Soos Creek summer-run steelhead | Soos Creek Hatchery | Big Soos Creek (WRIA 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Icy Creek Pond | Icy Creek (WRIA 09.0125), tributary to the Green River (WRIA 09.0001) at RM 48.3 | | | | ✓ | ✓ | ✓ |
| Soos Creek coho salmon | Soos Creek Hatchery | Big Soos Creek (WRIA 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Miller Creek Hatchery | Miller Creek (WRIA 09.0371) at approximately RM 1, on the grounds of the Southwest Suburban Sewer District Miller Creek Plant | | | | ✓ | ✓ | ✓ |
| | Des Moines Net Pens | Des Moines Marina (WRIA 09.0377) | | | | ✓ | ✓ | ✓ |
| | | Des Moines Creek (WRIA 09.0377) near Des Moines Marina | | | | | ✓ | |
| Keta Creek coho salmon | Soos Creek Hatchery | Big Soos Creek (WRIA 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | | | | | ✓ |
| | Keta Creek Complex | Crisp Creek (WRIA 09.0013) at RM 1.1, tributary to the Green River (WRIA 09.0001) entering at RM 40.1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Tacoma Water Headworks | Green River (WRIA 09.0001) at RM 61 | ✓ | | | | ✓ | ✓ |
| | NA | Green River (09.0001) at RM 60.5 | | | | | ✓ | ✓ |
| | Elliott Bay Net Pens | Elliott Bay, near Pier 70 at Seattle waterfront (WRIA 9.0072) | | | | | ✓ | |

Table 2. Hatchery facilities, locations, and activities associated with 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin. All programs use facilities that exist under current conditions and are operated under current conditions, except for the three FRF hatchery programs, continued.

| Hatchery Program | Facility | Location | Broodstock Collection | Spawning Facilities | Incubation Facilities | Rearing Facilities | Juvenile Fish Release | Monitoring and Evaluation |
|---|---|---|---|---|---|---|---|---|
| Marine Technology Center coho salmon | Marine Technology Center | Seahurst Park, Burien | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Soos Creek Hatchery | Big Soos Creek (WRIA 09.0072) at RM 0.6, tributary to the Green River (WRIA 09.0001) at RM 33.6 | ✓ | | | | | ✓ |
| FRF coho salmon | FRF | Green River (WRIA 09.0001) at RM 60 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Tacoma Water Headworks | Green River (WRIA 09.0001) at RM 61 | ✓ | | | | | ✓ |
| Keta Creek chum salmon | Keta Creek Complex | Crisp Creek (WRIA 09.0013) at RM 1.1, tributary to the Green River (WRIA 09.0001) at RM 40.1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Duwamish-Green River Basin areas accessible to natural-origin salmon and steelhead migration, spawning, and rearing | Duwamish-Green River Basin areas, including tributaries, extending from Elliott Bay and river mouths to the upstream extent of anadromous fish access. | | | | | | ✓ |

Sources: Muckleshoot Indian Tribe 2014a, 2014b, 2014c, 2014d; Muckleshoot Indian Tribe and Suquamish Tribe 2017; Muckleshoot Indian Tribe et al. 2019; WDFW 2013, 2014a, 2014b, 2014c, 2015, 2017; James Scott, WDFW, email sent to Charlene Hurst, NMFS, June 21, 2018, regarding clarification on release number for the Soos Creek fall-run Chinook salmon program; Schaffler 2019
NA: Not applicable.
RM: River mile, measured from the farthest downstream point on the stream in question.
WRIA: Water resources inventory area, typically defining a geographic area where surface water runoff drains into a common surface water body, such as a lake, section of stream, or bay.

Maximum annual releases of juvenile fish under the Proposed Action for each hatchery program that are analyzed in this EIS are shown in Table 3 below.

Table 3. Maximum annual releases from 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin under the Proposed Action.

| Hatchery Program | Program Type[1] | Maximum Annual Release Level[2] |
|---|---|---|
| Soos Creek fall-run Chinook salmon | Integrated harvest[3] | 4,200,000 subyearlings<br>300,000 yearlings |
| FRF fall-run Chinook salmon | Integrated harvest[3] | 600,000 subyearlings |
| Green River late winter-run steelhead | Integrated conservation | 33,000 yearlings |
| FRF late winter-run steelhead | Integrated harvest[4] | 350,000 yearlings |
| Soos Creek summer-run steelhead | Isolated harvest | 100,000 yearlings |
| Soos Creek coho salmon | Integrated harvest | 630,000 yearlings<br>120,000 fry |
| Keta Creek coho salmon | Integrated harvest | 2,050,000 yearlings |
| Marine Technology Center coho salmon | Isolated harvest/education | 10,000 yearlings |
| FRF coho salmon | Integrated harvest | 600,000 yearlings |
| Keta Creek chum salmon | Integrated harvest | 5,000,000 fry |

Sources: Muckleshoot Indian Tribe 2014a, 2014b, 2014c, 2014d; Muckleshoot Indian Tribe and Suquamish Tribe 2017; WDFW 2013, 2014a, 2014b, 2014c, 2015

[1] Program type:
**Integrated**: a hatchery program with harvest and/or conservation and recovery management objectives that intends for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns in both a hatchery and in the natural environment. Differences between hatchery-origin and natural-origin fish are minimized, and hatchery-origin fish are integrated with the local populations included in an evolutionarily significant unit (ESU) or distinct population segment (DPS) and can contribute to conservation or recovery of listed species.
**Isolated**: a hatchery program that intends for the hatchery-origin population to be reproductively segregated from the natural-origin population. These programs produce fish that are different from local populations. They do not contribute to conservation or recovery of populations included in an ESU or DPS.

[2] In years of high within-hatchery survival, juvenile production levels higher than the proposed release levels may occur. The co-managers plan to limit production to no more than 110 percent of levels described in the HGMPs, and an overage of 10 percent is anticipated to be a rare occurrence. If the running 5-year average production for a species life stage is more than 105 percent of the maximum level specified, the co-managers will notify NMFS and identify program changes, if any, to maintain approved maximum release levels.

[3] The FRF fall-run Chinook salmon would be an isolated harvest program under Alternative 5, whereby the Soos Creek fall-run Chinook salmon and FRF fall-run Chinook salmon programs would be genetically linked. Returns from an integrated component at Soos Creek Hatchery would then be used as broodstock for an isolated component at Soos Creek Hatchery and will be used as broodstock for an isolated program at the FRF when it becomes operational.

[4] Under Alternative 5, the FRF late winter-run steelhead program would be an integrated conservation harvest program.

The proposed FRF would be funded by the City of Tacoma through its Department of Public Utilities (TPU) and operated by the Muckleshoot Indian Tribe under the 1995 Settlement Agreement between the Muckleshoot Indian Tribe and the City of Tacoma regarding the municipal water supply operations in the Duwamish-Green River Basin. The proposed FRF would support three HGMPs that would rear and release juvenile fall-run Chinook salmon, steelhead, and coho salmon into the Green River watershed. Under the Settlement Agreement, TPU in consultation with the Muckleshoot Indian Tribe, would fund the design, engineering, environmental review, permitting, construction, and regulatory review and approval of the FRF. No dates have been established for construction and implementation of the FRF. The proposed FRF for fall-run Chinook salmon, steelhead, and coho salmon hatchery programs would be constructed near Green River RM 60.

For the proposed FRF and the existing three Soos Creek Hatchery programs, this EIS evaluates the environmental effects of implementing the HGMPs as proposed. Additional proposed improvements or changes to facilities or programs may require supplemental analysis if and when those improvements or changes are proposed. In addition, this EIS does not evaluate impacts that might be associated with the future construction of facilities for the proposed FRF hatchery programs, as that construction is not part of the Proposed Action.

As described in Subsection 1.5.3, NMFS' Determination as to Compliance with the 4(d) Rule, NMFS would require monitoring and evaluation as a condition of its approvals under the 4(d) Rule. Monitoring and evaluation under approved HGMPs would address the performance of the hatchery programs in meeting and adaptively managing their objectives. Monitoring activities (Table 2) would include, but not be limited to, obtaining information on smolt-to-adult survival, fishery contribution, natural-origin and hatchery-origin spawning abundance, juvenile outmigrant abundance and diversity, genetics, and juvenile and adult fish health when the fish are in hatchery facilities.

## 1.3 Purpose of and Need for the Proposed Action

This EIS identifies the purpose and need for the NMFS action and objectives of the state and tribal fisheries co-managers.

The purpose of the Proposed Action from NMFS' perspective is to evaluate the submitted HGMPs for ESA compliance. The need for the Proposed Action is to ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound. NMFS will ensure it meets its

tribal trust stewardship responsibilities and will also work collaboratively with the Muckleshoot Indian Tribe, Suquamish Tribe, and WDFW to protect and conserve listed species.

The co-managers' objectives in developing and submitting the 10 HGMPs for salmon and steelhead hatchery programs in the Duwamish-Green River Basin as an RMP under Limit 6 of the 4(d) Rule are to operate their hatcheries to meet resource management and protection goals with the assurance that any harm, death, or injury to fish within a listed evolutionarily significant unit (ESU) or distinct population segment (DPS) does not appreciably reduce the likelihood of a species' survival and recovery and is not in the category of prohibited take under the 4(d) Rule. In addition, as summarized in the project's biological opinion (NMFS 2019), the co-managers desire to develop an alternative that would increase Chinook salmon hatchery production to address the endangered Southern Resident killer whale's need for its preferred prey.

The co-managers also have as an objective the continued operation of salmon and steelhead hatchery programs using existing facilities for conservation, mitigation, and tribal and non-tribal fishing opportunity pursuant to the Puget Sound Salmon Management Plan implemented under *United States v. Washington,* and treaty rights preservation purposes while meeting ESA requirements.

WDFW and the Puget Sound treaty tribes strive to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and steelhead and their ecosystems to sustain treaty ceremonial and subsistence fisheries, treaty and non-treaty commercial and recreational fisheries, non-consumptive fish benefits, and other cultural and ecological values.

As described in Box 1-3, NMFS has an obligation to administer the provisions of the ESA and to protect listed salmon and steelhead, and also has a Federal trust responsibility to treaty Indian tribes. Thus, NMFS seeks to harmonize the reduction in the negative effects of hatchery programs with the provision of hatchery-origin fish for tribal harvest and for conservation purposes.

This EIS does not document whether specific actions of hatchery programs meet the requirements of Limit 6 of the 4(d) Rule under the ESA. Those ESA decisions will be made in separate processes consistent with applicable regulations as required by the ESA (Subsection 1.5.3, NMFS' Determination as to Compliance with the 4(d) Rule).

**Box 1-3. How does NMFS harmonize its conservation mandate under the ESA with stewardship of treaty Indian fishing rights?**

In addition to the biological requirements for conservation under the ESA, NMFS has a Federal trust responsibility to treaty Indian tribes. In recognition of its treaty rights stewardship obligation and consistent with Secretarial Order 3206 (see Subsection 1.7.7, Secretarial Order 3206), NMFS, as a matter of policy, will make every effort to harmonize the protection of listed species and the provision for tribal fishing opportunity. NMFS recognizes that the treaty tribes have a right to conduct their fisheries within the limits of conservation constraints. Because of the Federal government's trust responsibility to the tribes, NMFS is committed to considering the tribal co-managers' judgment and expertise regarding conservation of trust resources. Limit 6 of the 4(d) Rule explicitly requires this.

## 1.4 Project and Analysis Areas

The project area is the geographic area where the Proposed Action would take place (Figure 1). It includes the places where the proposed salmon and steelhead hatchery programs would (1) collect broodstock; (2) spawn, incubate, and rear fish; (3) release fish; or (4) remove surplus hatchery-origin adult salmon and steelhead that return to hatchery facilities; and (5) conduct monitoring and evaluation activities. The project area consists of the Duwamish-Green River Basin, as well as the following primary hatchery and satellite facilities and their immediate surroundings:

- Soos Creek Hatchery
- Icy Creek Pond
- Palmer Pond
- Miller Creek Hatchery
- Tacoma Water Headworks Diversion Fish Trap
- FRF (facilities to be constructed)
- Flaming Geyser Pond
- Elliott Bay Net Pens
- Marine Technology Center
- Des Moines Net Pens
- Keta Creek Complex

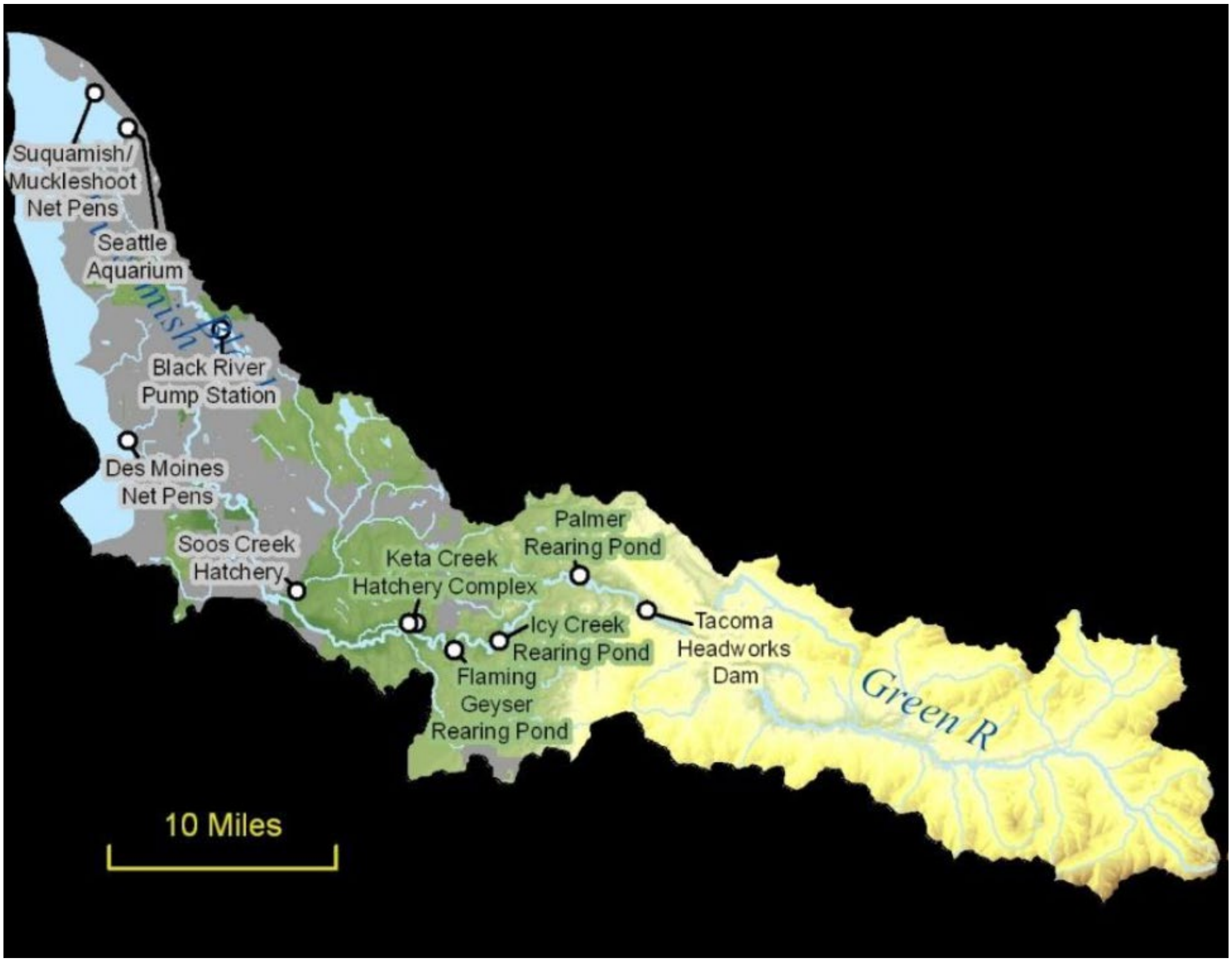


Figure 1. Project area and locations of primary hatchery facilities. Taken from WDFW (2014a).

The river basin is 93 miles long, covers nearly 500 square miles, and is located entirely within King County. The upper watershed is mostly forested, while the lower watershed is urban and industrial. While the Green River provides 83 miles of freshwater habitat, the Duwamish River in the lower basin provides a 6-mile zone where fresh and salt water mix. Major tributaries of the basin include the Black River, Springbrook Creek, Mill Creek, Soos Creek, Jenkins Creek, Covington Creek, Newaukum Creek, and Crisp Creek. Along the marine shoreline, smaller streams drain directly to Puget Sound. The upper watershed also supports the City of Tacoma's municipal water source and diversion dam, which was built in 1911 (at RM 61), and also supports the U.S. Army Corps of Engineers (USACE) Howard Hanson Dam (RM 64) which was completed in 1962. Howard Hanson Dam blocks fish passage to over 45 percent of the upper Green River watershed. Although the dams were built without fish passage facilities, fish passage improvements have occurred and more are planned. The Green and

Duwamish Rivers were historically separate rivers; however, in 1909, modifications to the Duwamish and Green Rivers resulted in the two rivers joining as one watershed.

The analysis area is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. The analysis area is described at the beginning of Chapter 3, Affected Environment, for each resource.

## 1.5 Decisions to be Made

NMFS must decide on the following before the Preferred Alternative can be implemented:

- The Preferred Alternative, following an analysis of all alternatives in this EIS and review of public comment on the EIS
- Whether the Preferred Alternative complies with ESA criteria under the 4(d) Rule

### 1.5.1 Preferred Alternative is Identified in the Final EIS

Although a Preferred Alternative was not identified in the draft EIS, it has been identified in the final EIS in Subsection 2.2.5, Alternative 5 (Increased Production/Preferred Alternative). Information from the public review process was used in selecting the Preferred Alternative.

### 1.5.2 Record of Decision

This NEPA process will culminate in a Record of Decision (ROD) that will record NMFS' selected alternative. The ROD will identify all the alternatives considered by NMFS, identify the environmentally preferable alternative, describe the preferred alternative and the selected alternative, and summarize the impacts expected to result from implementation of the selected alternative. Similar to the preferred alternative in the final EIS, the selected alternative in the ROD could be the preferred alternative or could be a combination of components of alternatives evaluated in the final EIS. The ROD will also consider comments on the final EIS. The ROD will be completed after public review and comment on the final EIS, and after the ESA determinations and associated public review processes are completed.

### 1.5.3 NMFS' Determination as to Compliance with the 4(d) Rule

Discussions between the co-managers and NMFS during development of hatchery RMPs are conducted with the knowledge and understanding that the specific criteria under Limit 5 and Limit 6 of the 4(d) Rule must be met before take coverage under the ESA can be issued. Criteria for ESA evaluation of

HGMPs that form RMPs submitted under Limit 6 are derived from (and therefore the same as for) Limit 5 (Artificial Propagation). HGMPs must:

1. Specify the goals and objectives for the hatchery program.
2. Specify the donor population's critical and viable threshold levels.
3. Prioritize broodstock collection programs to benefit listed fish.
4. Specify the protocols that will be used for spawning and raising the hatchery-origin fish.
5. Determine the genetic and ecological effects arising from the hatchery program.
6. Describe how the hatchery operation relates to fishery management.
7. Ensure that the hatchery facility can adequately accommodate listed fish if collected for the program.
8. Monitor and evaluate the management plan to ensure that it accomplishes its objective.
9. Be consistent with tribal trust obligations (65 Fed. Reg. 42422, July 10, 2000).

NMFS has a limited role (i.e., approve or deny) under Limit 6 of the 4(d) Rule. The decision as to whether the criteria under Limit 6 of the 4(d) Rule have been met will be documented in NMFS' ESA decision documents at the end of the ESA evaluation process. Under Limit 6 of the 4(d) Rule, NMFS will prepare a Pending Evaluation and Proposed Determination (PEPD) document for the proposed RMP and will take public comment on that document. Included with the ESA decision documents will be responses to comments on the HGMPs received during public review as required by the 4(d) Rule.

### 1.5.4 Biological Opinion on NMFS' Determination as to Compliance with the 4(d) Rule

Section 7(a)(2) of the ESA provides that any action authorized, funded, or carried out by a Federal agency shall not jeopardize the continued existence of any endangered or threatened species or result in the adverse modification or destruction of designated critical habitat. NMFS' actions under section 4(d) are Federal actions, and NMFS must comply with section 7(a)(2). NMFS' consultations under section 7 on those actions rely on the best available science, and therefore may be informed by this NEPA analysis. The results of these consultations are documented in biological opinions developed by NMFS and the U.S. Fish and Wildlife Service (USFWS; collectively the Services) for the species under their jurisdiction. Biological opinions are produced near the end of the ESA evaluation and determination process, providing the Services conclusions regarding the likelihood that the proposed hatchery actions would jeopardize the continued existence of any listed species or adversely modify designated critical habitat for any listed species.

## 1.6 Scoping and Relevant Issues

The first step in preparing an EIS is to conduct scoping of the issues that may be associated with the Proposed Action. This occurs through internal agency and public scoping processes. The purpose of scoping is to identify the relevant human environmental issues, to eliminate insignificant issues from detailed study, and to identify the alternatives to be analyzed in the EIS. Scoping can also help determine the level of analysis and the types of data required for analysis.

Scoping concluded (e.g., NMFS 2015) that the impacts of the proposed action on the human environment would be similarly negligible for some resources or parts of resources (water quality and human health, because hatchery operations would substantially comply with state clean water regulations, and wildlife, because there would be no substantial impacts on wildlife species). Therefore, these resources were not proposed to be analyzed (81 Fed. Reg. 26776, May 4, 2016). NEPA analyses of HGMPs for salmon and steelhead hatchery programs in a number of river basins reached similar conclusions. These analyses, which are listed below, were considered in the analyses of those resources in this EIS and incorporated by reference as appropriate.

- Final Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan Satisfy the Endangered Species Act Section 4(d) Rule – herein referred to as the Elwha FEA (NMFS 2012) (77 Fed. Reg. 75611, December 21, 2012)
- Final Supplemental Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan Satisfy the Endangered Species Act 4(d) Rule – herein referred to as the Elwha FSEA (NMFS 2014b) (79 Fed. Reg. 35318, June 20, 2014)
- Final Environmental Assessment to Analyze the Impacts of NOAA's National Marine Fisheries Service Determination that Three Hatchery Programs for Dungeness River Basin Salmon as Described in Joint State-Tribal Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule – herein referred to as the Dungeness Hatcheries FEA (NMFS 2016a)
- Final Environmental Assessment to Analyze the Impacts of NOAA's National Marine Fisheries Service Determination that 10 Hatchery Programs for Hood Canal Salmon and

Steelhead as Described in Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule – herein referred to as the Hood Canal Hatcheries FEA (NMFS 2016b)

### 1.6.1 Notices of Public Scoping

Public scoping for this EIS commenced with publication of a Notice of Intent in the Federal Register on May 4, 2016 (81 Fed. Reg. 26776, May 4, 2016). That notice started a 30-day public comment period (May 4, 2016, to June 3, 2016) to gather information on the scope of the issues and the range of alternatives to be analyzed in the EIS. NMFS developed a website for the EIS at http://www.westcoast.fisheries.noaa.gov/hatcheries/salmon_and_steelhead_hatcheries.html. The website was available during the scoping period and will be updated and available throughout the project duration. Notifications of the public scoping process were distributed in emails to a list of over 4,200 addresses that had been compiled from people that commented on earlier hatchery EISs, including the PS Hatcheries DEIS (NMFS 2014a). Electronic and other notifications were sent to agencies, private individuals, businesses, and non-governmental organizations that contained a link to the website for this EIS and the address to the EIS electronic mailbox.

### 1.6.2 Written Comments Received during the Public Scoping Process

Submissions in writing received on this EIS during the public scoping process included:

- 1 letter from a governmental agency
- 20 emails from individual citizens

### 1.6.3 Issues Identified During Scoping

Based on all input received during the scoping process and in consideration of the purpose and need for the Proposed Action, input relevant to development of EIS alternatives generally included:

- Identify improvements in hatcheries and their operation that would reduce negative effects on natural-origin salmon and steelhead without reducing production.
- Modify hatchery programs to provide more fishing opportunities for salmon and steelhead.

Comments from public scoping also noted the importance of the need to address potential negative effects of releases from hatcheries on the salmon and steelhead resource, expressed concerns about genetics, and expressed concerns about degraded water quality in the lower reaches of the Duwamish-Green River Basin.

### 1.6.4 Public Review and Comment

Under NEPA, the draft EIS was issued for an initial 45-day public review period, which was extended another 30 days in response to public requests for extension of the comment period. The draft supplemental EIS was issued for an initial 45-day public review period, which was extended another 15 days to allow additional time for the public and agencies to comment because the original comment period overlapped the government shutdown from December 22, 2018, to January 25, 2019. The public comment periods were announced in newspapers, through electronic distribution to interested parties, and by publication in the Federal Register (82 Fed. Reg. 51237, November 3, 2017; 82 Fed. Reg. 59597, December 15, 2017).

NMFS received 26 letters and emails on the draft EIS, including:

- 2 letters from governmental agencies
- 1 email from a non-governmental organization
- 23 emails from individual citizens

NMFS received 15 letters and emails on the draft supplemental EIS, including:

- 2 letters from governmental agencies
- 13 emails from individual citizens

Following the public review periods, responses to substantive public comments on the draft EIS and draft supplemental EIS were prepared and included in this final EIS. Responses identify any changes to the EIS resulting from public comments, as warranted. Appendix C, Comments on the Draft EIS and Draft Supplemental EIS and NMFS Responses, summarizes public comments received on the draft EIS and draft supplemental EIS and provides responses to those comments.

Although not required by Council on Environmental Quality (CEQ) regulations, NMFS may consider public comments received on the final EIS in preparing the ROD. The ROD will be prepared no sooner than 30 days after the final EIS is released. Under Limit 6 of the 4(d) Rule, the PEPD document prepared by NMFS for the proposed RMP (Subsection 1.5.3, NMFS' Determination as to Compliance with the 4(d) Rule) will be made available for public review and comment for 30 days (Table 4).

Table 4. NMFS and USFWS documents and decisions required under the ESA and NEPA regarding salmon and steelhead hatchery programs, public notices, and comment opportunities.

| Determination | Federal Register Notice of Intent and Public Scoping Comment Period | Federal Register Notice of Availability and Public Comment Period | Federal Register Notice of Availability and Public Access | Decision Document |
|---|---|---|---|---|
| **ESA** | | | | |
| NMFS 4(d) | | Pending Evaluation and Determination (30-day comment period) | | Evaluation and Recommendation Determination[1] |
| NMFS BiOp[2] | | | | Signed BiOp |
| USFWS BiOp | | | | Signed BiOp |
| **NEPA** | | | | |
| EIS[3] | Notice of Intent (30-day comment period) | Draft EIS (45-day comment period) | Final EIS (30-day "cooling off" period) | Record of Decision |
| **Progression of Steps for Each Determination** | Start | | | End |

[1] Notification of decision published in Federal Register.
[2] BiOp = biological opinion under section 7 of the ESA.
[3] EIS = environmental impact statement.

After the ROD is prepared, if the co-managers propose substantive changes to the HGMPs reviewed in this EIS, or if substantial new information becomes available after completion of this EIS, additional NEPA compliance may be warranted. Such efforts could entail public review and comment on supplemental or new documents to the extent required by NEPA law and regulation.

## 1.7 Relationship to Other Plans and Policies

In addition to NEPA and ESA, other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect hatchery operations in the Duwamish-Green River Basin. They are summarized below to provide additional context for the hatchery programs and their proposed HGMPs (see Box 1-1), and the analyses in Chapter 3, Affected Environment, Chapter 4, Environmental Consequences, and Chapter 5, Cumulative Effects, of this EIS.

### 1.7.1 Clean Water Act

The Clean Water Act (33 United States Code [USC] 1251, 1977, as amended in 1987), administered by the U.S. Environmental Protection Agency (EPA) and state water quality agencies, is the principal Federal legislation directed at protecting water quality. Maintenance of high water quality consistent with the Clean Water Act is essential for ensuring the survival and productivity of natural-origin

salmon and steelhead. The Act also helps ensure that the hatchery-origin fish produced under the Proposed Action (Subsection 1.2, Description of the Proposed Action) are supplied with clean water during rearing in the hatcheries, and after their release into the natural environment, to protect their health and foster their survival to return as adults. Each state implements and carries forth Federal provisions, as well as approves and reviews National Pollutant Discharge Elimination System (NPDES) applications, and establishes total maximum daily loads for rivers, lakes, and streams. The states are responsible for setting the water quality standards needed to support all beneficial uses, including protection of public health, recreational activities, aquatic life, and water supplies.

The Washington State Water Pollution Control Act, codified as Revised Code of Washington (RCW) Chapter 90.48, designates the Washington Department of Ecology (Ecology) as the agency responsible for carrying out the provisions of the Federal Clean Water Act within Washington State. The agency is responsible for establishing water quality standards, making and enforcing water quality rules, and operating waste discharge permit programs. These regulations are described in Washington Administrative Code (WAC) Title 173. Hatchery operations are typically required to comply with the Clean Water Act by maintaining active NPDES permits[2].

### 1.7.2 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 USC 668-668c), enacted in 1940, and amended several times since then, prohibits the taking of bald eagles, including their parts, nests, or eggs. The act defines “take” as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." The USFWS, who is responsible for carrying out provisions of this Act, defines “disturb” to include “injury to an eagle; a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.” As described in Subsection 3.4, Wildlife, and under the Proposed Action and alternatives analyzed in this EIS in Subsection 4.4, Wildlife, hatchery production has the potential to affect the productivity of eagles protected under this Act through changes in the number of salmon and steelhead available as prey.

[2] Hatchery facilities and associated NPDES permit numbers: Soos Creek Hatchery (WAG13-3014); Icy Creek Pond (WAG13-3013); Palmer Pond (WAG13-3002); and Keta Creek Complex (WAG13-0020). Permits are not required under the Upland Fin-Fish Hatching and Rearing general NPDES permit for the Marine Technology Center, Des Moines Net Pens, Flaming Geyser Pond, Miller Creek Hatchery, and Elliott Bay Net Pens. Each of these facilities does not produce greater than 20,000 pounds of fish on site and does not use greater than 5,000 pounds of fish feed per month.

### 1.7.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361) as amended, establishes a national policy designated to protect and conserve wild marine mammals and their habitats. This policy was established so as not to diminish such species or populations beyond the point at which they cease to be a significant functioning element in the ecosystem, nor to diminish such species below their optimum sustainable population. All marine mammals are protected under the MMPA.

The MMPA prohibits, with certain exceptions, the take of marine mammals in United States waters and by United States citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. The term "take," as defined by the MMPA, means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA further defines harassment as "any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

NMFS is responsible for reviewing Federal actions for compliance with the MMPA. As described in Subsection 3.4, Wildlife, and under the Proposed Action and alternatives analyzed in Subsection 4.4, Wildlife, hatchery production has the potential to indirectly affect marine mammals, including Southern Resident killer whales that are protected under the MMPA, through changes in the number of salmon and steelhead available as prey.

### 1.7.4 Executive Order 12898

In 1994, the President issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-income Populations*. The objectives of the Executive Order include developing Federal agency implementation strategies, identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process. As described in Subsection 3.6, Environmental Justice, and under the Proposed Action and alternatives analyzed in Subsection 4.6, Environmental Justice, hatchery production has the potential to affect the extent of harvest available for minority and low-income populations that are the focus of Executive Order 12898, including the Muckleshoot Indian Tribe and Suquamish Tribe.

### 1.7.5 Treaties of Point Elliott, Medicine Creek, and Point No Point

Beginning in the mid-1850s, the United States entered into a series of treaties with tribes in Puget Sound. The treaties were completed to secure the rights of the tribes to land and the use of natural resources in their historically inhabited areas, in exchange for the ceding of land to the United States for settlement by its citizens. The first treaty was the Treaty of Medicine Creek (signed in 1854), followed by two treaties signed in 1855: the Point Elliott Treaty and the Point No Point Treaty. These treaties secured the rights of tribes for taking fish at usual and accustomed grounds and stations in common with all citizens of the United States. Marine and freshwater areas of Puget Sound were affirmed as the usual and accustomed fishing areas for treaty tribes under *United States v. Washington* (1974).

The Muckleshoot Indian Tribe and Suquamish Tribe are signatories to the Treaty of Point Elliott, which is the lands settlement treaty between the United States government and the tribes of the North Puget Sound and Strait of Georgia area, in the recently formed Washington Territory. The Treaty of Point Elliott was signed on January 22, 1855, at Muckl-te-oh or Point Elliott, now Mukilteo, Washington. The salmon and steelhead fishing rights of the Muckleshoot Indian Tribe and Suquamish Tribe in the usual and accustomed fishing areas are reserved under the treaties, in particular the Treaty of Point Elliott, and NMFS' Federal trust responsibility with respect to those rights as described in Subsection 1.7.7, Secretarial Order 3206, and Subsection 1.7.8, The Federal Trust Responsibility. The treaties complement the implementation of federally approved recovery plans for listed salmon and steelhead in Puget Sound (Subsection 1.7.12, Recovery Plans for Puget Sound Salmon and Steelhead). As described in Subsection 3.6, Environmental Justice, and under the Proposed Action and alternatives analyzed in Subsection 4.6, Environmental Justice, the treaty influences environmental impacts to minority and low-income populations, including the Muckleshoot Indian Tribe and Suquamish Tribe.

### 1.7.6 *United States v. Washington*

Salmon and steelhead fisheries within the project area are jointly managed by the WDFW and Puget Sound treaty tribes (co-managers) under the continuing jurisdiction of *United States v. Washington* (1974). *United States v. Washington* (1974) is the Federal court proceeding that enforces and implements reserved treaty fishing rights with regard to salmon and steelhead returning to Puget Sound. Hatcheries in Puget Sound provide salmon and steelhead for these fisheries. Without many of these hatcheries, there would be few, if any, fish for the tribes to harvest (Stay 2012; Northwest Indian Fisheries Commission [NWIFC] 2013). These fishing rights and attendant access were established by treaties the Federal government signed with the tribes in the 1850s (Subsection 1.7.5, Treaties of Point Elliott, Medicine Creek, and Point No Point). In those treaties, the tribes agreed to allow the peaceful

settlement of Indian lands in western Washington in exchange for their continued right to fish, gather shellfish, hunt, and exercise other sovereign rights. In 1974, Judge George Boldt decided in *United States v. Washington* that the tribes' fair and equitable share was 50 percent of all the harvestable fish destined for the tribes' traditional fishing places. Hatchery-origin fish are considered fish to the same extent as natural-origin fish and, thus, are counted in the determination of the treaty share (*United States v. Washington*, 759 F.2d 1353, 1358-60 (9th Cir.), cert. denied, 474 U.S. 994 [1985]). In the recent ruling in the Culverts subproceeding of *United States v. Washington*, the Federal District Court held that the treaty right imposes a duty on the state to refrain from degrading salmon and steelhead habitat by maintaining fish-blocking culverts on state roads and highways (20 F. Supp. 3d 828, 889 [W.D. Wa. 2007], aff'd 2220 F.3d 836 [9th Cir. 2016]). The joint state-tribal RMPs submitted to NMFS for review and approval under Limit 6 of the 4(d) Rule, including the HGMPs described under the Proposed Action, are implemented within the parameters of *United States v. Washington*.

### 1.7.7 Secretarial Order 3206

Secretarial Order 3206 (*American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA*, http://www.nmfs.noaa.gov/sfa/reg_svcs/Councils/Webinar/secretarial_order.pdf), issued by the secretaries of the Departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under the ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the Order. The Secretarial Order acknowledges the trust responsibility and treaty obligations of the United States toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the Order, the Services "will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation."

In the event that the Services determine that conservation restrictions directed at a tribal activity are necessary to protect listed species, specifically where the activity could result in incidental take under the ESA, the Services shall provide the affected tribe(s) written notice, including an analysis and determination that (i) the restriction is reasonable and necessary for conservation of the species; (ii) the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities; (iii) the measure is the least restrictive alternative available to achieve the required conservation

purpose; (iv) the restriction does not discriminate against Indian activities, either as stated or applied; and (v) voluntary tribal measures are not adequate to achieve the necessary conservation purpose.

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Section 5, Principle 1).
- Recognize that Indian lands are not subject to the same controls as Federal public lands (Section 5, Principle 2).
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Section 5, Principle 3).
- Be sensitive to Indian culture, religion, and spirituality (Section 5, Principle 4).

Additionally, the U.S. Department of Commerce issued a Departmental Administrative Order (DAO) addressing Consultation and Coordination with Indian Tribal Governments (DAO 218-8, April 26, 2012; http://www.osec.doc.gov/opog/dmp/daos/dao218_8.html), which implements relevant Executive Orders, Presidential Memoranda, and Office of Management and Budget Guidance. The DAO describes actions to be "followed by all Department of Commerce operating units … and outlines the principles governing Departmental interactions with Indian tribal governments." The DAO affirms that the "Department works with Tribes on a government-to-government basis to address issues concerning … tribal trust resources, tribal treaty, and other rights."

Secretarial Order 3206 and the DAO affect the Federal process described in Subsection 1.6, Scoping and Relevant Issues, and relationships influencing the analysis of resources evaluated in this EIS, including Subsection 4.2, Salmon and Steelhead, Subsection 4.5, Socioeconomics, and Subsection 4.6, Environmental Justice.

### 1.7.8 The Federal Trust Responsibility

The United States government has a trust or special relationship with Indian tribes. The unique and distinctive political relationship between the United States and Indian tribes is defined by statutes, executive orders, judicial decisions, and agreements and differentiates tribes from other entities that deal with, or are affected by, the Federal government. Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments,* states that the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal government has enacted

numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes.

The relationship has been compared to one existing under common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources of the United States as the trust corpus (*Dep't of the Interior v. Klamath Water Users Protective Ass'n*, 532 US 1, 11, 2001). The trust responsibility has been interpreted to require Federal agencies to carry out their activities in a manner that is protective of Indian treaty rights. This policy is also reflected in the March 30, 1995, document, *Department of Commerce – American Indian and Alaska Native Policy* (U.S. Department of Commerce 1995). The Ninth Circuit Court of Appeals has held, however, that "unless there is a specific duty that has been placed on the government with respect to Indians, [the government's general trust obligation] is discharged by [the government's] compliance with general regulations and statutes not specifically aimed at protecting Indian tribes" (Gros Ventre Tribe v. United States, 2006, citing Morongo Band of Mission Indians v. FAA, 1998; United States v. Jicarilla Apache Nation, U.S., 131 S.Ct. 2313, 180 L.Ed.2nd 187, 2011).

As an agency mandate, NMFS' implementation of its Federal trust responsibilities influences the analysis of resources evaluated in this EIS, especially regarding Subsection 4.2, Salmon and Steelhead, Subsection 4.5, Socioeconomics, and Subsection 4.6, Environmental Justice.

### 1.7.9 Tribal Policy for Salmon Hatcheries

The Puget Sound treaty tribes' (tribes) *Tribal Policy Statement for Salmon Hatcheries in the Face of Treaty Rights at Risk* (NWIFC 2013) was submitted to NMFS and WDFW by the tribes for the purpose of reaffirming "the role salmon and steelhead hatcheries play in implementing the treaty right to fish and in recovering salmon populations in the face of continuing loss of salmon habitat by degradation and climate change." The Policy acknowledges that state and Federal governments historically developed and used hatcheries as a means of mitigating for the loss of habitat and natural production they had permitted. The Policy states that "As long as watersheds, the Salish Sea estuary, and the ocean are unable to maintain self-sustaining salmon populations in sufficient abundance, hatcheries will remain an integral and indispensable component of salmon management. Hatcheries are necessary for tribes to be able to harvest salmon in their traditional areas to carry out the promises of the treaties fully and meet the requirements of *United States vs. Washington* and *Hoh vs. Baldrige*." The analyses in this EIS take into account the need to protect tribal trust resources as described in Subsection 1.7.8, The Federal Trust Responsibility, including the contributions of hatcheries under the Proposed Action and the alternatives, to meeting treaty reserved fishing rights.

### 1.7.10 Washington State Endangered, Threatened, and Sensitive Species Act

This EIS considers the effects of hatchery programs and harvest actions on state endangered, threatened, and sensitive species that have a relationship with salmon and steelhead. The State of Washington has species of concern listings (WAC Chapters 232-12-014 and 232-12-011) that include all state endangered, threatened, sensitive, and candidate species. These species are managed by WDFW, as needed, to prevent them from becoming endangered, threatened, or sensitive. The state-listed species are identified on WDFW's website (https://wdfw.wa.gov/species-habitats/at-risk/listed\\parametrix.com\pmx\PSO\Projects\Clients\8017-Ocean Assoc\553-8017-001 PSH_NEPA_Support\99Svcs\WP\01_DuwGreen\FEIS\Chapters\)) an are updated periodically as needed. The criteria for listing and de-listing, and the requirements for recovery and management plans for these species are provided in WAC Chapter 232-12-297. The state list is separate from the Federal ESA list; the state list includes species status relative to Washington State jurisdiction only. Critical wildlife habitats associated with state or federally listed species are identified in WAC Chapter 222-16-080. Species on the state endangered, threatened, and sensitive species list are reviewed in this EIS if the Proposed Action and the alternatives could affect these species (Subsection 3.4, Wildlife, and Subsection 4.4, Wildlife).

### 1.7.11 Hatchery and Fishery Reform Policy

WDFW's Hatchery and Fishery Reform Policy (Policy C-3619) was adopted by the Washington Fish and Wildlife Commission in 2009 (Washington Fish and Wildlife Commission 2009). It supersedes WDFW's Wild Salmonid Policy, which was adopted in 1997. Its purpose is to advance the conservation and recovery of wild salmon and steelhead by promoting and guiding the implementation of hatchery reform. The policy applies to WDFW hatchery actions included under the Proposed Action and the alternatives reviewed in this EIS. It is NMFS' understanding that the HGMPs WDFW submitted to NMFS for review and approval were prepared with the intent to improve hatchery effectiveness, ensure compatibility between hatchery production and salmon recovery plans and rebuilding programs, and support sustainable fisheries.

### 1.7.12 Recovery Plans for Puget Sound Salmon and Steelhead

A Federal recovery plan associated with the project area addressed in this EIS is in place for the ESA-listed Puget Sound Chinook salmon (NMFS 2006; Shared Strategy for Puget Sound 2007; 72 Fed. Reg. 2493, January 19, 2007). Broad partnerships of Federal, state, local, and tribal governments and community organizations collaborated in the development of the recovery plan under Washington's Salmon Recovery Act. The comprehensive recovery plan includes conservation goals and proposed

habitat, hatchery, and harvest actions needed to achieve the conservation goals for each watershed within the geographic boundaries of the listed ESUs. Subsequently, NMFS released for public review a draft framework (the Population Recovery Approach [PRA]) that categorized the relative role of each Chinook salmon population and watershed that supports them for consultation and recovery planning purposes, into one of three "tiers[3]" (75 Fed. Reg. 82208, December 29, 2010). The Green River Chinook salmon population and watershed are in Tier 2. Tier 2 populations are of secondary importance for recovery, compared to Tier 1 populations which must achieve low extinction risk status. Although the Puget Sound Steelhead DPS was listed in 2007, a recovery plan has not yet been completed, but is currently in the process of assembly. A draft plan is projected to be completed in 2018 with a final plan completed in 2019 (http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/puget_sound/overview_puget_sound_steelhead_recovery_2.html). The recovery plans as well as the required 5-year status assessments produced by NMFS provide information that is fundamental to the analysis of existing conditions for listed salmon and steelhead resources (Subsection 3.2, Salmon and Steelhead), and the analysis of effects on listed salmon and steelhead under the Proposed Action and the alternatives (Subsection 4.2, Salmon and Steelhead).

## 1.8 Organization of the Final EIS

The EIS should be reviewed in conjunction with the co-managers' HGMPs for the 10 Duwamish-Green River Basin salmon and steelhead hatchery programs (http://www.westcoast.fisheries.noaa.gov/hatcheries/Duwamish-Green/duw-green_hgmps.html), which contain more detailed information and explanations of hatchery programs affecting Puget Sound resources. Links to online sources of information used in the EIS are active at the time of publication; however, NMFS cannot guarantee that they will remain active over time.

[3] Under the PRA, Tier 1 Chinook salmon populations are of primary importance for preservation, restoration, and ESU recovery and have to be viable for the ESU as a whole to meet viability criteria in Ruckelshaus et al. (2002). If not assigned to Tier 1, populations with cumulative scores relative to the ESU-wide mean that are greater than the ESU-wide mean are assigned to Tier 2, whereas scores below the ESU-wide mean are assigned to Tier 3. Impacts on Tier 1 populations would be more likely to affect the viability of the ESU as a whole than similar impacts on Tier 2 or Tier 3 populations, because of the primary importance of Tier 1 populations to overall ESU viability. Tier 2 populations would be less important for recovery to a low extinction risk status. Tier 3 populations would be allowed to absorb more effects but would still require ESA protection so that the populations maintain a trajectory toward recovery, albeit over a longer term than for Tier 1 and Tier 2 populations (NMFS 2010).

The contents of this EIS are described briefly below:

- **Introductory Materials**. Prior to Chapter 1 are a cover sheet, summary, list of acronyms, glossary of key terms, and table of contents.
- **Chapter 1**. This chapter provides the background and context leading to the development of the Proposed Action. It describes the purpose and need for the action; background and decisions to be made; scoping and relevant issues; and the relationship of this action to other plans, regulations, and laws.
- **Chapter 2**. This chapter describes each of the alternatives and lists their major components. The No-action Alternative is included, along with four action alternatives, including the Proposed Action and Preferred Alternative, and alternatives considered but not analyzed in detail.
- **Chapter 3**. This chapter describes the existing environmental setting (i.e., existing conditions) that would be affected by the alternatives. It includes subsections on water quantity and quality, salmon and steelhead, other fish species, wildlife (Southern Resident killer whales), socioeconomics, environmental justice, and human health resources.
- **Chapter 4**. This chapter contains descriptions and analyses of the potential direct and indirect effects of each alternative on the resources identified in Chapter 3. It also compares the action alternatives to the No-action Alternative.
- **Chapter 5**. This chapter addresses cumulative impacts, which are the incremental effects of an action when added to other past, present, and reasonably foreseeable actions, regardless of what agency or person undertakes such actions. Climate change is addressed in this chapter.
- **Remaining Material**. This material includes a list of references, distribution list, list of preparers, index, and appendices.

THIS PAGE INTENTIONALLY LEFT BLANK

# Chapter 2

## 2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the five alternatives evaluated in this EIS. The alternatives are fully described in this chapter, and their environmental effects are presented in Chapter 4, Environmental Consequences. Specifically, this chapter describes the following:

- How the alternatives were developed
- Alternatives that were analyzed in detail
- Alternatives that were considered but eliminated from detailed analysis
- A Preferred Alternative

### 2.1 Development of Alternatives

In 2016, NMFS solicited and considered public comment on the development of alternatives for this EIS (Subsection 1.6, Scoping and Relevant Issues). In the Notice of Intent to develop this EIS (81 Fed. Reg. 26776, May 4, 2016), NMFS identified three alternatives for possible analysis: the Proposed Action (NMFS' approval under the 4(d) Rule of implementation of the co-managers' HGMPs), no action (no NMFS approval of the HGMPs under the 4(d) Rule), and a decreased hatchery production alternative (50 percent decrease in number of salmon and steelhead released and NMFS approval of the HGMPs under the 4(d) Rule).

The scoping process (Subsection 1.6, Scoping and Relevant Issues) identified eight potential alternatives, including those proposed in the Notice of Intent. Of these eight alternatives, four were found to represent the full range of reasonable alternatives because their components differed meaningfully from the other alternatives analyzed. Two of the alternatives other than the No-action Alternative (Proposed Action and Reduced Production), meet the purpose and need for the Proposed Action. Four potential alternatives were carefully considered but eliminated from detailed analysis because (1) they are already encompassed by other alternatives analyzed in detail and thus would not

provide substantive new information for the decision-maker to consider, or (2) do not meet the purpose and need for the Proposed Action.

Following release of the draft EIS for public comment, a revised HGMP for the Green River late winter-run steelhead program was submitted to NMFS that would increase production by 22,000 yearlings (WDFW 2017a). In addition, the project's biological opinion (NMFS 2019) includes terms and conditions for Alternative 5 that would decrease production for the FRF late winter-run steelhead program by 100,000 yearlings compared to Alternative 1 and Alternative 2, as well as additional conservation measures for Chinook salmon and steelhead programs not included in the other action alternatives. These changes are analyzed as part of Alternative 5, and hatchery production levels under Alternative 5 are shown in Table 5.

## 2.2 Alternatives Analyzed in Detail

Five alternatives are evaluated in this final EIS: (1) NMFS would not make a determination under the 4(d) Rule (No Action), (2) NMFS would make a determination that the submitted HGMPs meet the requirements of the 4(d) Rule (Proposed Action), (3) NMFS would make a determination that the submitted HGMPs would not meet the requirements of the 4(d) Rule (Termination), (4) NMFS would make a determination that revised HGMPs with reduced production levels would meet requirements of the 4(d) Rule (Reduced Production), and (5) NMFS would make a determination that HGMPs with increased production levels (compared to the Proposed Action) and biological opinion terms and conditions would meet the requirements of the 4(d) Rule (Increased Production/Preferred Alternative). Maximum annual production levels by species under the alternatives are summarized in Table 5.

Monitoring activities would be part of the provisions of approved HGMPs under Alternative 2, Alternative 4, and Alternative 5 (Table 2), and would include, but not be limited to, obtaining information on smolt-to-adult survival, fishery contribution, natural-origin and hatchery-origin spawning abundance, juvenile outmigrant abundance and diversity, genetics, and juvenile and adult fish health when the fish are in the hatchery.

Table 5. Maximum annual hatchery releases of juvenile salmon and steelhead under the alternatives by species.

| Species | Alternative 1 (No Action) | Alternative 2 (Proposed Action) | Alternative 3 (Termination) | Alternative 4 (Reduced Production) | Alternative 5 (Increased Production/ Preferred Alternative |
|---|---|---|---|---|---|
| Fall-run Chinook salmon[1] | 5,100,000 | 5,100,000 | 0 | 2,550,000 | 7,100,000 |
| Late winter-run steelhead [2] | 383,000 | 383,000 | 0 | 191,500 | 305,000[7] |
| Summer-run steelhead[3] | 100,000 | 100,000 | 0 | 50,000 | 100,000 |
| Coho salmon[4] | 3,410,000 | 3,410,000 | 0 | 1,705,000 | 3,410,000 |
| Chum salmon[5] | 5,000,000 | 5,000,000 | 0 | 2,500,000 | 5,000,000 |
| **Total[6]** | **13,993,000** | **13,993,000** | **0** | **6,996,500** | **15,915,000** |

Sources: Muckleshoot Indian Tribe 2014a, 2014b, 2014c, 2014d; Muckleshoot Indian Tribe and Suquamish Tribe 2017; Muckleshoot Indian Tribe et al. 2019; WDFW 2013, 2014a, 2014b, 2014c,2015, 2017a; James Scott, WDFW, email sent to Charlene Hurst, NMFS, June 21, 2018, regarding clarification on release number for the Soos Creek fall-run Chinook salmon program; Schaffler 2019

[1] Applies to the Soos Creek fall-run Chinook salmon HGMP and the FRF fall-run Chinook salmon HGMP (WDFW 2013; Muckleshoot Indian Tribe 2014d; Muckleshoot Indian Tribe et al. 2019; James Scott, WDFW, email sent to Charlene Hurst, NMFS, June 21, 2018, regarding clarification on release number for the Soos Creek fall-run Chinook salmon program).

[2] Applies to the Green River late winter-run steelhead HGMP and the FRF late winter-run steelhead HGMP (Muckleshoot Indian Tribe 2014a; Schaffler 2019; WDFW 2014c; WDFW 2017a).

[3] Applies to the Soos Creek summer-run steelhead HGMP (WDFW 2015).

[4] Applies to the Soos Creek coho salmon HGMP, Keta Creek coho salmon HGMP, Marine Technology Center coho salmon HGMP, and the FRF coho salmon HGMP (Muckleshoot Indian Tribe 2014c; WDFW 2014a, WDFW 2014b; Muckleshoot Indian Tribe and Suquamish Tribe 2017).

[5] Applies to the Keta Creek chum salmon HGMP (Muckleshoot Indian Tribe 2014b).

[6] In years of high within-hatchery survival, juvenile production levels higher than the proposed release levels, as shown above, may occur. The co-managers plan to limit production to no more than 110 percent of levels described in the HGMPs, and an overage of 10 percent is anticipated to be a rare occurrence. If the running 5-year average production for a species life stage is more than 105 percent of the maximum level specified, the co-managers will notify NMFS and identify program changes, if any, to maintain approved maximum release levels.

[7] During the public comment period for the draft EIS, a revised HGMP for the Green River late winter-run steelhead program was submitted (WDFW 2017a), proposing to release an additional 22,000 steelhead yearlings. After publication of the draft supplemental EIS, the FRF late winter-run steelhead program was changed from 350,000 to 250,000 yearlings, decreasing the total release level for steelhead by 78,000 yearlings, as referenced in the biological opinion (NMFS 2019). This results in production of 78,000 fewer steelhead yearlings compared to Alternative 1 and Alternative 2.

### 2.2.1 Alternative 1 (No Action) – Do Not Make a Determination under the 4(d) Rule

Under this alternative, NMFS would not make a determination under the 4(d) Rule for any of the 10 HGMPs, and the hatchery programs would not be exempted from ESA section 9 take prohibitions. If the programs are not authorized under the No-action Alternative, several possible outcomes could occur:

- The applicants could pursue obtaining an ESA section 10(a)(1)(B) incidental take permit to exempt the hatchery programs from take prohibitions.
- The applicants could choose to operate the hatchery programs without ESA authorization and be liable for ESA take violations.
- The applicants could choose to terminate the hatchery programs because they would not have ESA authorization.

For the purposes of this analysis, NMFS has defined the No-action Alternative as the choice by the applicants to continue the hatchery programs without ESA authorization and to potentially change hatchery production levels at any time within facility constraints. NMFS made this choice for a variety of reasons, including the lengthy history of ongoing operations and the existence of tribal treaty rights for harvest that is at least partly related to the production. For the purposes of this analysis, production from the three FRF hatchery programs would be included under Alternative 1, as described in Subsection 2.2.2, Alternative 2 (Proposed Action), and a maximum of 13,993,000 hatchery-origin salmon and steelhead would be released annually (Table 5). No new environmental protection or enhancement measures would be implemented. Monitoring as described in the HGMPs may or may not occur.

The No-action Alternative represents NMFS' best estimate of what may happen in the absence of the Proposed Action. No-action Alternative hatchery production levels by hatchery program and salmon and steelhead species are based on HGMPs submitted prior to 2015. Revisions to production levels and other HGMP changes have occurred since then and are evaluated under Alternative 5.

### 2.2.2 Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would make a determination that the HGMPs submitted by the co-managers meet requirements of the 4(d) Rule. The 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin would be implemented as described in the 10 submitted HGMPs (Muckleshoot Indian Tribe 2014a, 2014b, 2014c, 2014d; Muckleshoot Indian Tribe and Suquamish Tribe 2017; WDFW 2013, 2014a, 2014b, 2014c, 2015) and Subsection 1.2, Description of the Proposed Action.

Under Alternative 2, the total annual maximum release level would be 13,993,000 hatchery-origin salmon and steelhead (Table 5) as follows:

- Fall-run Chinook salmon up to 5,100,000
- Late winter-run steelhead up to 383,000
- Summer-run steelhead up to 100,000
- Coho salmon up to 3,410,000
- Chum salmon up to 5,000,000

The hatchery programs would use hatchery capacity as described in the HGMPs for operations, and would be adaptively managed over time to incorporate best management practices (BMPs) as new information is available. These may include practices such as reducing release levels during times of extremely poor ocean survival, or developing water re-use or recirculation systems or contingency plans for hatchery operations at times of low flow and high water temperature.

### 2.2.3 Alternative 3 (Termination) – Make a Determination that the Submitted HGMPs Do Not Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would make a determination that the HGMPs as proposed do not meet the standards prescribed under Limit 5 and Limit 6 of the 4(d) Rule, and the 10 salmon and steelhead hatchery programs in the Duwamish-Green River Basin would be terminated. All salmon and steelhead being raised in hatchery facilities (i.e., fall-run Chinook salmon, late winter-run steelhead, summer-run steelhead, coho salmon, and chum salmon) would be released or killed, and no broodstock would be collected.

NMFS does not expect this alternative to meet the applicants' objectives for the action because substantial progress toward Chinook salmon and steelhead conservation and recovery in the Duwamish-Green River Basin would be unlikely under this alternative. Additionally, this alternative would not fulfill treaty-reserved fishing rights or provide fishing opportunities for citizens of Washington State. However, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios, including those that do not achieve all the applicants' specific objectives. This is useful where existing conditions include hatchery effects as an ongoing feature. This termination alternative assists NMFS in comparing the Proposed Action to a hypothetical environment without hatcheries, which is important for gauging the extent of effects resulting from the Proposed Action.

### 2.2.4 Alternative 4 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under this alternative, the applicants would reduce the number of fish released from each of the 10 proposed hatchery programs. Revised HGMPs would be submitted reflecting these reduced production levels, and NMFS would make a determination that the revised HGMPs meet the requirements of the 4(d) Rule.

For the purposes of analysis, NMFS will evaluate a 50 percent reduction from the proposed hatchery programs (total releases would be up to 6,996,500 hatchery-origin juveniles) because it represents a mid-point between the Alternative 2 (Proposed Action) and Alternative 3 (Termination). Note that NMFS' regulations under the 4(d) Rule do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs. NMFS' regulations under the 4(d) Rule require NMFS to make a determination that the HGMPs *as proposed* either meet or do not meet the standards prescribed under Limit 5 and Limit 6 of the 4(d) Rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.

Under Alternative 4, the total annual maximum release level would be 6,996,500 hatchery-origin salmon and steelhead (Table 5) as follows:

- Fall-run Chinook salmon up to 2,550,000
- Late winter-run steelhead up to 191,500
- Summer-run steelhead up to 50,000
- Coho salmon up to 1,705,000
- Chum salmon up to 2,500,000

### 2.2.5 Alternative 5 (Increased Production) – Make a Determination that the HGMPs with Increased Production Levels and Biological Opinion Terms and Conditions Meet the Requirements of the 4(d) Rule

Under this alternative, there would be increased hatchery production for Chinook salmon and decreased production for steelhead compared to Alternative 1 (No Action) and Alternative 2 (Proposed Action). The applicants would increase the number of Chinook salmon by 2,000,000 subyearlings for the Soos Creek fall-run Chinook salmon program. The applicants would also increase the number of steelhead yearlings released from the Green River late winter-run steelhead program by 22,000 fish and decrease the number of yearlings released from the FRF late winter-run steelhead program by 100,000 fish for a

total decrease of 78,000 steelhead yearlings released compared to Alternative 1 and Alternative 2. In addition, through review of these hatchery programs, the project's biological opinion (NMFS 2019) includes terms and conditions to reduce hatchery effects on Chinook salmon and steelhead. HGMP supplements would need to be submitted to meet the terms and conditions of the biological opinion, and NMFS would make a determination that the 10 HGMPs meet the requirements of the 4(d) Rule.

Under Alternative 5, the total annual maximum release level would be 15,915,000 hatchery-origin salmon and steelhead (Table 5) as follows:

- Fall-run Chinook salmon up to 7,100,000
- Late winter-run steelhead up to 305,000
- Summer-run steelhead up to 100,000
- Coho salmon up to 3,410,000
- Chum salmon up to 5,000,000

All other aspects of the other salmon and steelhead hatchery programs would be as described in the draft EIS under Alternative 2 (Proposed Action). Production from the three FRF hatchery programs would be included under Alternative 5.

### 2.3 Alternatives Considered But Not Analyzed in Detail

The following additional four alternatives identified during the scoping processes (Subsection 1.6, Scoping and Relevant Issues) were carefully considered, but NMFS determined that (1) they are already encompassed by other alternatives analyzed in detail and thus would not provide substantive new information for the decision-maker to consider, or (2) do not meet the purpose and need for the Proposed Action (Subsection 1.3, Purpose of and Need for the Proposed Action). These alternatives are:

- Increase production of hatchery-origin fish.
- Incorporate recommendations or reforms to maximize hatchery program performance at levels of production identified in submitted HGMPs.
- Maximize recovery potential for listed species.
- Use additional BMPs.

<u>Hatchery programs with greater levels of hatchery production than those proposed</u> – Under this potential alternative, the co-managers (WDFW, Muckleshoot Indian Tribe, and Suquamish Tribe)

would revise their HGMPs to incorporate substantially higher production levels for species other than Chinook salmon and steelhead than those proposed, primarily to increase fishery benefits but which may also require construction of additional facilities to accommodate increased production levels. This alternative is not analyzed in detail because substantially higher production levels would exceed fish rearing density limits for the hatchery facilities and result in increasingly negative fish health and survival impacts on the hatchery-origin fish. In addition, substantially higher production levels may increase negative effects outside of the hatchery facility (e.g., competition and predation on natural-origin salmon and steelhead and other fish species). Constructing additional hatchery facilities to accommodate substantially increased production would not meet the purpose and need for the action, which includes using existing hatchery facilities described in the HGMPs. In addition, substantially higher production levels would have greater negative impacts than under the Proposed Action and would not meet NMFS' need to protect and conserve listed species. However, increased production for specific species (e.g., Chinook salmon) that could be accommodated within existing facility infrastructure and would help meet conservation goals for listed species would be considered as described under Alternative 5.

<u>Incorporate recommendations or reforms to maximize hatchery performance at proposed production levels</u> – Under this potential alternative, identified improvements to hatchery programs (e.g., independent recommendations of the Hatchery Scientific Reviews Group [HSRG] from 2002 to 2004, or potential improvements as identified in HGMPs) would be implemented as an action alternative, but at the same production levels as under the Proposed Action. The Washington Recreation and Conservation Office (RCO) (2016) indicates continuing and substantial progress has been made in increasing the percentage of WDFW's Puget Sound hatchery programs that meet HSRG standards. In addition, HSRG and related recommendations are already being incorporated into HGMPs, and the co-managers intend to continue to implement such recommendations (including monitoring and evaluation) over time using adaptive management under the Proposed Action. Thus, this potential alternative is not analyzed in detail because it would not be meaningfully different from the Proposed Action as it relates to the purpose and need.

<u>Maximize recovery potential for listed species</u> – Under this potential alternative, the hatchery programs would be designed to reduce risks to and increase benefits for the recovery of listed species. However, under the action alternatives, the numbers of released salmon and steelhead would be reduced (Alternative 4) or terminated (Alternative 3), effectively reducing or eliminating risks to listed species from the programs. In addition, under the Proposed Action, 8 of the 10 hatchery programs are integrated hatchery programs, which are intended to contribute to the conservation and recovery of

listed species. The two isolated programs are the Soos Creek summer-run steelhead hatchery program and the Marine Technology Center coho salmon program, which would produce only 110,000 of the 13,993,000 fish under the Proposed Action. Thus, for the above reasons, this potential alternative is not analyzed in detail because it would not be measurably different from the action alternatives.

Use additional BMPs – Under this potential alternative, NMFS would approve the 10 proposed hatchery programs and require implementation of additional BMPs to further reduce the risk of adverse impacts of the hatchery programs on natural-origin salmon and steelhead populations. Similar to the alternative considered above (Incorporate recommendations or reforms to maximize hatchery performance at proposed production levels), because the proposed HGMPs have already incorporated BMPs identified by independent reviewers and because the HGMPs allow for the incorporation of additional BMPs in the future as a result of monitoring and evaluation activities, this alternative would not be meaningfully different from the Proposed Action and is not analyzed in detail.

## 2.4 Selection of a Preferred Alternative

A Preferred Alternative is identified in this final EIS. The agency's Preferred Alternative is "the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors" (CEQ 1981). The Preferred Alternative may be one of the alternatives or a combination of components of more than one alternative, possibly varying for each hatchery program. As explained in Subsection 1.6.4, Public Review and Comment, NMFS reviewed 41 letters and emails from agencies and the public commenting on the draft EIS and draft supplemental EIS. Information obtained during the public review process for both the draft EIS and draft supplemental EIS was used in choosing a Preferred Alternative. NMFS has identified Alternative 5 as its Preferred Alternative because it would meet the components of the purpose and need for this action regarding socioeconomic and cultural benefits to recreational and tribal fishing interests, as well as benefit biological resources. In particular, increased hatchery production of Chinook salmon under Alternative 5, compared to the other alternatives, would help increase the availability of adult Chinook salmon over the long term, which would benefit Southern Resident killer whales.

# Exhibit 13

Final

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

October 21, 2020

Memorandum For: The File

FROM: Richard Turner

SUBJECT: Pacific Salmon Treaty Production Increases at Spring Creek NFH Little White Salmon NFH, and Willard NFH for Brood Years 2020.

In this file memorandum, NOAA's National Marine Fisheries Service (NMFS) is evaluating its 2020 funding of increased hatchery fall Chinook salmon production in 2020 to meet the need to increase prey availability for Southern Resident Killer Whales (SRKW).

As part of the Proposed Action analyzed in the biological opinion on domestic actions related to the 2018 Pacific Salmon Treaty Agreement (NMFS 2019), NMFS proposed funding hatchery production programs with the goal of producing an increase in prey availability for SRKW of three to four percent in areas that are most important to SRKWs. The proposed action in the opinion proposes that NMFS will fund increases in hatchery Chinook salmon releases of up to twenty million smolts with five to six million smolts coming from the Puget Sound hatcheries and the remainder from hatcheries along the Washington Coast and in the Columbia River (NMFS 2019).

NMFS with the assistance of Columbia River fisheries managers identified a number of hatchery programs in the Columbia River that have the capacity to produce additional Chinook salmon juveniles that could potentially increase prey availability for SRKW. Parties to the *U.S. v Oregon Agreement* reached consensus on a number of hatchery programs managed within the Agreement where added production could be produced to meet the goal of the proposed action.

The U.S. Fish and Wildlife Service (USFWS) has proposed increased fall Chinook salmon production for three of their hatchery programs (Table 1).

Table 1. Current and proposed production for the LWS NFH URB Fall Chinook Salmon, Willard NFH URB Fall Chinook Salmon, and Spring Creek NFH Tule Fall Chinook Salmon programs.

| Program | Current Production | Proposed Increase | Totals |
|---|---|---|---|
| LWS NFH URB Fall Chinook salmon | 4,500,000 | 450,000 | 4,950,000 |
| Willard NFH URB Fall Chinook salmon | 2,000,000 | 200,000 | 2,200,000 |
| Spring Creek NFH Tule Fall Chinook salmon | 10,500,000 | 2,000,000 | 12,500,000 |
| Totals | 18,000,000 | 2,050,000 | 20,050,000 |

The three programs listed in the table above were evaluated and their impacts on listed species in a 2007 biological opinion (2007 Opinion) (NMFS 2007). In 2015, the Spring Creek NFH Tule program was reduced to the current level of 10.5M from 15.1M and the funding source changed to from a mix of Mitchell Act and U.S. Army Corps of Engineers (Corps) funding to 100% Corps funding (Turner 2015). In 2017, the LWS NFH URB Fall Chinook Salmon program was revised (NMFS 2017) to reflect an increase in production from 2.5M to 4.5M, and a change in funding to the Corps. The Corps funds these programs as part of the larger John Day Dam/The Dalles Dam Mitigation program (JDM) that is intended to mitigate for loss production due to the construction and operation of the John Day Dam and The Dalles Dam. Under this proposal NMFS will fund additional increases in production at these facilities for broodyear 2020.

Based on current smolt to adult survivals for broodyears 2008-2012, the proposed increases in production for 2020 at the LWS NFH and Willard NFH URB fall Chinook salmon programs could potentially contribute over 6,331 adult Chinook salmon to the prey base for SRKW. Similarly, the Spring Creek NFH increase, using the same metric, could also potentially contribute over 18,520 adult Chinook salmon to the prey base.

**White Salmon River Chinook Salmon Populations**

Impacts from the proposed increased production may affect the White Salmon River tule fall Chinook salmon population. The status of the White River population has been affected by past habitat impacts. Condit Dam on the White Salmon River was completed in 1913 with no juvenile or adult fish passage limiting fall Chinook salmon habitat to the 3.2 miles below the dam. Habitat in the White Salmon River was further reduced by the construction of Bonneville Dam that inundated habitat the lower portion of the river. Condit Dam was finally breached in October of 2011. The breaching of Condit Dam completely changed the lower reaches of the White Salmon utilized the tule fall Chinook salmon for spawning.

The number of fall Chinook salmon spawners in the White Salmon increased from low levels in the early 2000s but has declined as the habitat below Condit Dam recovers from the release of sediment from above the dam. Spawning has been dominated by tule Chinook salmon strays from the neighboring Spring Creek Hatchery and upriver bright Chinook salmon[1] from the production program in the adjoining Little White Salmon River (Table 2, Table 3). The Spring Creek NFH, which is located immediately downstream from the Little White Salmon River mouth, is the largest tule Chinook salmon production program in the Columbia basin, releasing approximately 10.5 million smolts annually. The White Salmon River was the original source for the hatchery broodstock, so whatever remains of the genetic heritage of the population is contained in the mix of hatchery and natural spawners. Beginning 2010, all returning Spring Creek NFH tule fall Chinook salmon were adipose fin-clipped, thus allowing more accurate abundance estimates of natural-origin tule fall Chinook salmon in the White Salmon River (Table 2). The drop in natural-origin returns since 2015 reflect the impacts from sediment movement on spawning habitat in the lower river after Condit Dam removal.

[1] These fish are not part of the LCR Chinook Salmon ESU.

Table 2. Big White Salmon River Tule Fall Chinook Salmon Escapement.

| Return Year | Natural Origin | Hatchery Origin |
|---|---|---|
| 2010 | 1,369 | 518 |
| 2011 | 640 | 83 |
| 2012 | 555 | 38 |
| 2013 | 648 | 336 |
| 2014 | 801 | 233 |
| 2015 | 375 | 398 |
| 2016 | 384 | 181 |
| 2017 | 402 | 345 |
| 2018 | 110 | 84 |
| 2019 | 382 | 243 |

Table 3. Big White Salmon River URB Fall Chinook Salmon Escapement. In 2011, spawning surveys were not conducted due to the fall removal of Condit Dam.

| Return Year | Natural Origin | Hatchery Origin |
|---|---|---|
| 2010 | 841 | 1,093 |
| 2011 | | |
| 2012 | 743 | 361 |
| 2013 | 1,221 | 2,165 |
| 2014 | 1,636 | 3,208 |
| 2015 | 1,741 | 6,944 |
| 2016 | 621 | 1,508 |
| 2017 | 487 | 753 |
| 2018 | 991 | 1,446 |
| 2019 | 2,058 | 7,177 |

In reviewing the proposed production increases, NMFS determined that there would not be additional impacts above those beyond those already evaluated in the 2007 Opinion due to the operation of the hatchery facilities, or due to the collection of adults. During current broodstock collection activities the LWS NFH and Spring Creek NFH, hatchery operators work to maximize the collection of hatchery adults to reduce the potential for hatchery adults to stray into the White Salmon River.

The production increase for the Spring Creek NFH Tule Fall Chinook Salmon program of 2.0M combined with the current program 10.5M would total 12.5M subyearlings, which is less than the 15.1M that was evaluated within the 2007 Opinion and thus impacts would be expected to be less than those evaluated in the 2007 Opinion.

The increase in URB Fall Chinook Salmon for both the Willard NFH and LWS NFH programs equates to an increase equivalent to a 10% increase in total releases. This level of increase on a one-time basis was previously reviewed in an existing biological opinion. In the 2007 Opinion, NMFS considered the impacts of production overages up to 110% of the original program production goal that can occur due to higher than expected fecundities and survival during rearing. NMFS included the Term and Condition (below) that required the USFWS to notify NMFS immediately if production was going to be substantially in excess (>110%) of the

program production goal such that NMFS could evaluated options to address the excess production. The proposed action described for 2020 is therefore not a change in the proposed action previously considered or in the impacts to listed species described in this Opinion.

> 1.e In the event that circumstances, such as unanticipated, higher-than-expected fecundity, or high egg-to-fry survival rates, lead to the inadvertent possession of salmon substantially in excess (>110 percent) of program production levels specified above, then NMFS must be notified immediately to determine future actions, unless specific actions for addressing excess production are provided in the HGMP.

The current proposal would not exceed 110% of the original production goal and thus NMFS would not expect additional impacts because programs do not exceed 110%. However, due to concerns with hatchery URB fall Chinook salmon from these programs straying into the White Salmon River NMFS included the Term and Condition (below) that required the USFWS to manage the program to limit the number of program hatchery fish not to exceed a 3-year moving average of 3,000 adults.

2b. The USFWS shall manage the program such that the abundance of hatchery-origin URB fall Chinook salmon produced under the Proposed Action that spawn naturally in the White Salmon River shall not exceed 3,000 adults, based on a 3-year moving average.

In 2019, with the escapement of 7,177 hatchery adult the URB fall Chinook salmon programs exceed the Term and Condition with a 3-year moving average of 3,125. The reason for the 3,000 adult hatchery spawner limit is the concern that the naturally spawning hatchery URB fall Chinook salmon are spawning on top of ESA-listed tule fall Chinook salmon redds (redd-superimposition) in the lower White Salmon River since they spawn after tule fall Chinook salmon. There was another concern with regards to the potential for spawning to overlap and the production of hybrid tule x URB fall Chinook salmon. Smith and Engle (2011) estimated that between 4.3% and 15.0% of the outmigrating juveniles sampled from 2007-2009 were tule x URB hybrids. Analysis has not found any hybrids in returning adults, nor have hatchery managers observed any, thus those hybrids likely do not contribute to the naturally spawning population (Smith and Engle 2011).

The USFWS has been attempting to repeat the Smith and Engle study, but changes in the lower river due to sediment from the removal of Condit Dam have prevented them from collecting enough juveniles for analysis. NMFS have been in discussions with the USFWS regarding actions that can be taken to address impacts from naturally spawning hatchery fish.

One of the actions that the USFWS is doing is working with the Washington Department of Fish and Wildlife (WDFW) biologists to determine if spawn timing and redd distribution have changed pre and post Condit Dam removal. This may indicate if redd superimposition and hybridization are still a risk.

To further reduce the number of hatchery spawners, the USFWS continues to maximize the removal of returning adult URB fall Chinook salmon at the LWS NFH, but facility constraints limit the number of adults that can be held at any one time and during the season the adult ladder

is closed when the adult ponds are filled. The USFWS has proposed changes to the facilities to increase adult holding capacity, but have not found funding for the upgrades.

The LWS NFH is the broodstock source for a number of URB Fall Chinook salmon programs including releases at Prosser Hatchery and Klickitat Hatchery. In 2018, adult returns to the LWS NFH were extremely short, such that program releases were reduced and the production for the Prosser programs were not filled. In 2019, the pre-season run-size estimates indicated that there was the potential for another shortfall in adult returns to LWS NFH. To ensure that the broodstock needs for all of the programs supported by the LWS NFH were met, the fisheries managers implemented a number of actions including curtailment of sport and tribal fisheries in the mainstem Columbia River and the closure of fisheries within Drano Lake (the backwater from the Bonneville Pool between the hatchery and the highway embankment). The also maximized collections at all URB fall Chinook salmon facilities. In 2019, the hatchery returns were better than expected and all program broodstock needs were filled. It is my opinion, that those fish that would have been harvested, but for the reductions in the mainstem and Drano Lake fisheries, mostly likely contributed to the increased escapement of hatchery fish into the White Salmon River in 2019. Since these fisheries restrictions are not expected to occur in the future, the number of strays into the White Salmon River should be similar to levels in the past. The 2020 in-season runsize estimates indicate the returns will be enough to meet broodstock needs for all programs, and broodstock from other locations can be used to backfill any short fall. Based on the estimated runsize fisheries are expected to occur and will be operated as they have in the past per the *U.S. v. Oregon* Agreement.

The proposed increases in fall Chinook salmon production are not expected to increase impacts on ESA-listed salmon and steelhead due to hatchery operations and broodstock collection. Impacts from ecological interactions within the migration corridor from the additional production is not expected to exceed those considered in the original opinions, since releases are not expected to exceed 110% of the original program goals. There is the potential for adults returning from the proposed increases to stray into the White Salmon River and as a result NMFS will continue to work with USFWS and WDFW to monitor the tule fall Chinook salmon population and the URB fall Chinook salmon escapement into the White Salmon River. The effects on listed species from hatchery production exceeding 110% of the proposed annual production was considered to be short term impacts because the additional production would not continue into the future but be limited to one year. If the proposed increases in production are expected to continue beyond the 2020 brood year then USFWS and NMFS should reinitiate the ESA Section 7 consultations for these three programs.

**References**

NMFS. 2007. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation. USFWS Artificial Propagation Programs in the Lower Columbia and Middle Columbia River. November 27, 2007. NMFS Consultation No.: NWR-2004-02625. 256p.

NMFS. 2017. Endangered Species Act Section 7(a)(2) Biological Opinion, Section 7(a)(2) Not Likely to Adversely Affect Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Little White Salmon National Fish Hatchery Upriver Bright Fall Chinook Salmon Program. October 5, 2017. NMFS Consultation No.: WCR-2015-2764. 175p.

NMFS. 2019. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska. NMFS Consultation No.: WCR-2018-10660. April 5, 2019. 443p.

Smith, C. T., and R. Engle. 2011. Persistent Reproductive Isolation between Sympatric Lineages of Fall Chinook Salmon in White Salmon River, Washington. Transactions of the American Fisheries Society. 140(3): 699-715.

Turner, R. 2015. Memorandum to the File. October 21, 2015. Reduction in the total number of tule fall Chinook salmon released annually from the Spring Creek NFH from 15.1 million to 10.5 million sub-yearlings, and a change in the funding agency from the NMFS (through the Mitchell Act) and the U.S. Army Corps of Engineers combined, to 100% of the program being funded by the U.S. Army Corps of Engineers. NMFS Consultation No.: NWR-2004-02625. 2p.

# Exhibit 14

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

October 21, 2020

Memorandum For: The File

FROM: Richard Turner

SUBJECT: Pacific Salmon Treaty Production Increases at the Little White Salmon NFH, for Brood Year 2020.

In this file memorandum, NOAA's National Marine Fisheries Service (NMFS) is evaluating its 2020 funding of increased hatchery spring Chinook salmon production to meet the need to increase prey availability for Southern Resident Killer Whales (SRKW).

As part of the Proposed Action analyzed in the biological opinion on domestic actions related to the 2018 Pacific Salmon Treaty Agreement (NMFS 2019), NMFS proposed funding hatchery production programs with the goal of producing an increase in prey availability for SRKW of three to four percent in areas that are most important to SRKWs. The proposed action in the opinion proposes that NMFS will fund increases in hatchery Chinook salmon releases of up to twenty million smolts with five to six million smolts coming from the Puget Sound hatcheries and the remainder from hatcheries along the Washington Coast and in the Columbia River (NMFS 2019).

NMFS with the assistance of Columbia River fisheries managers identified a number of hatchery programs in the Columbia River that had the capacity to produce additional Chinook salmon juveniles that could potentially increase prey availability for SRKW. Parties to the *U.S. v Oregon Agreement* reached consensus on a number of hatchery programs managed within the Agreement where added hatchery production could be produced to meet the goal of the Proposed Action.

The U.S. Fish and Wildlife Service (USFWS) has proposed increased spring Chinook salmon production at the Little White Salmon NFH (LWS NFH) (Table 1). The added production could potentially produce an additional 3,720 adults, based on current smolt to adult survival rates, to add to the SRKW prey base.

Table 1. Current and proposed production for the LWS NFH Spring Chinook Salmon program.

| Program | Current Production | Proposed Increase | Total |
|---|---|---|---|
| LWS NFH Spring Chinook salmon | 1,000,000 | 400,000 | 1,400,000 |

NMFS currently funds the 1,000,000 spring Chinook salmon production through the Mitchell Act and would fund the proposed additional production through with funds as described in the NMFS 2019 proposed action . The LWS NFH spring Chinook salmon program and its impacts on listed species was evaluated in a 2007 biological opinion (NMFS 2007). In reviewing the

proposed production increase for 2020, NMFS determined that there would not be additional impacts above those beyond those already evaluated in 2007 Opinion due to the operation of the hatchery facilities, or due to the collection of adults. During current broodstock collection activities the LWS NFH, hatchery operators work to maximize the collection of hatchery adults to reduce the potential for hatchery adults to stray.

LWS NFH releases of spring Chinook salmon do not tend to stray into other listed populations. The closest listed spring Chinook salmon population is in the Hood River in Oregon, which is within the Bonneville Pool and upstream of the mouth to the Little White Salmon River and Drano Lake (the backwater from the Bonneville Pool between the hatchery and the river mouth). For broodyear releases from 2001 to 2014, 5,525 coded-wire tags (CWTs) have been recovered in fisheries, hatchery returns, and on the spawning grounds. Out of this total, only 50 CWTs have been recovered on the spawning grounds, with the majority recovered below the hatchery in the Little White Salmon River. Only 1 CWT from the LWS NFH has been recovered in the Hood River, from the 2003 broodyear. This recovery was expanded to an estimated 6 adults. Based on the very low level of straying exhibited by the current releases of LWS NFH spring Chinook salmon, the proposed additional release of 400,000 smolts is not expected to noticeably increase the number of hatchery adults that would stray into ESA-listed naturally spawning populations.

The increase in spring Chinook salmon at the LWS NFH is a 40% increase above current releases. In the 2007 Opinion, NMFS considered the impacts of production overages up to 110% of the original program production goal. NMFS included a Term and Condition (below) that required the USFWS to notify NMFS immediately if production was going to be substantially in excess (>110%) of the program production goal such that NMFS could evaluated options to address the excess production.

> *1.e In the event that circumstances, such as unanticipated, higher-than-expected fecundity, or high egg-to-fry survival rates, lead to the inadvertent possession of salmon substantially in excess (>110 percent) of program production levels specified above, then NMFS must be notified immediately to determine future actions, unless specific actions for addressing excess production are provided in the HGMP.*

The proposed increase in the release of spring Chinook salmon at LWS NFH of 400,000 exceeds the 110% limit and thus impacts may exceed those in the evaluated in the 2007 Opinion.

These additional impacts on ESA-listed juvenile fish from hatchery releases would be expected to result from ecological interactions within the migration corridor. NMFS has developed the PCD Risk tool to estimate the potential impacts from these interactions.

In reviewing competition and predation effects between hatchery and natural-origin juveniles in the mainstem Columbia River, NMFS used the PCD Risk model of Pearsons and Busack (2012) to quantify the potential number of natural-origin salmon and steelhead juveniles lost to competition and predation from the release of hatchery-origin juveniles. Although model logic is still largely as described in Pearsons and Busack (2012), the PCD Risk model has undergone considerable modification since then to increase supportability and reliability. Notably, the

current version no longer operates in a Windows environment and no longer has a probabilistic mode. We also further refined the model by allowing for multiple hatchery release groups of the same species to be included in a single run. The one modification to the logic was a 2018 elimination of competition equivalents and replacement of the disease function with a delayed mortality parameter. The rationale behind this change was to make the model more realistic; competition rarely directly results in death in the model because it takes many competitive interactions to suffer enough weight loss to kill a fish. Weight loss is how adverse competitive interactions are captured in the model. However, fish that are competed with and suffer some degree of weight loss are likely more vulnerable to mortality from other factors such as disease. Now, at the end of each run, the competitive impacts for each fish are assessed, and each fish has a probability of delayed mortality based on the competitive impacts. This function will be subject to refinement based on research. For now, the probability of delayed mortality is equal to the proportion of a fish's weight loss. For example, if a fish has lost 10% of its body weight due to competition and a 50% weight loss kills a fish, then it has a 20% probability of delayed death, (0.2 = 0.1/0.5). Parameter values used in the model runs are shown in Table 2 - Table 5.

For our model runs, we assumed a 100 percent population overlap between hatchery fish and all natural-origin species present. These releases are assumed to overlap with natural-origin chum, coho, sockeye, spring, and fall Chinook salmon, and steelhead in the mainstem Columbia River. Fish are directly released from LWS NFH into Drano Lake and thus would not overlap with young of the year juveniles, because natural spawning is limited to a small area below the barrier dam that is inundation by the Bonneville Pool reservoir. However, hatchery fish would overlap with listed salmon and steelhead in the mainstem Columbia River.

The model was run in two segments: from release to Bonneville Dam, and a run from Bonneville Dam through the estuary. The juvenile hatchery spring Chinook salmon are expected to be released from the LWS NFH around mid-April.

Release location to Bonneville Dam: The release from the LWS NFH was analyzed for this stretch because all fish migrate through this area. The following assumptions were made for these model runs:

- Travel (residence) time was proportional to what the fish's travel time was from mouth of the Little White Salmon River to Bonneville Dam.
- Survival rate of hatchery fish was the survival from release to Bonneville Dam.
- Temperatures at the Bonneville Dam were used in model runs.
- Model runs account for hatchery fish predation and competition effects on natural-origin age 0 and age 1 Chinook salmon, age 2 steelhead, sockeye salmon age 1 and 2 (combined), and age 2 coho salmon, because these fish commingle with the hatchery-origin fish at in the Columbia River above Bonneville Dam.
- Natural-origin fish sampled at Bonneville Dam were used to determine the mean fish length that was used for input into the model. NMFS believes this provides an accurate estimate of the fish sizes that would be encountered by program releases.

For the aggregate model run from Bonneville Dam through the estuary the following assumptions were made for these model runs:

- Travel (residence) time was proportional to what the fish's travel time was from mouth of the Little White Salmon River to Bonneville Dam.
- Survival rate of hatchery fish below Bonneville Dam to the mouth of the Columbia River is assumed to be the same as from release to Bonneville Dam.
- Hatchery-origin fish numbers for the program releases were reduced from the original release number by using the survival rate to Bonneville Dam.
- Temperatures at Bonneville Dam were used in model runs.
- Model runs account for hatchery fish predation and competition effects on natural-origin Chinook salmon age 0 and 1, steelhead age 2, sockeye salmon age 1 and 2 (combined), age 0 chum salmon, and coho salmon age 2.

Table 2. Parameters from the PCD Risk model that are the same across all programs.

| Parameter | Value[1] |
|---|---|
| Habitat complexity | 0.1 |
| Population overlap | 1.0 |
| Habitat segregation | 0.3 for Chinook salmon;<br>0.6 for all other species |
| Dominance mode | 3 |
| Piscivory | 0.002 for Chinook, Coho, and Chum salmon (when interacting with yearling summer/fall Chinook salmon);<br>0 for all other species |
| Maximum encounters per day | 3 |
| Predator:prey length ratio for predation | 0.25[2] |

[1] All values from HETT (2014) unless otherwise noted.
[2] Daly et al. (2014)

Table 3. Age and size of listed natural-origin salmon and steelhead encountered by juvenile hatchery fish after release.

| Species | Age Class | Size in mm (SD)(CV) | Source |
|---|---|---|---|
| Chinook salmon | 0 | 103 (13.3)(0.13) | 6/1 – 10/31/2019[1] |
| | 1 | 147 (25.1)(0.17) | [1] |
| Steelhead | 2 | 191 (22.2)(0.12) | [1] |
| Sockeye salmon | 2 | 124 (16.9)(0.14) | [1] |
| Coho salmon | 2 | 146 (16.8)(0.12) | [1] |
| Chum Salmon | 0 | 40 (NA)(0.08) | [1] |

[1] Fish Passage Center, last accessed: July 24, 2020 (Smolt Monitoring Program 2019 Juveniles at Bonneville Dam)(mean size for natural-origin (unclipped) subyearling and yearling Chinook Salmon, yearling steelhead, yearling sockeye and coho salmon). Chum Salmon from Hillson et al. (2017).

Table 4. Hatchery fish parameter values for the PCD Risk model run from release of fish to Bonneville Dam.

| Program | Release Site Columbia River (RM) | Release Number | Size in mm (SD) at release | Survival Rates to Bonneville (mean) | Travel (residence) Time (median days) | | Temp. at release(° C)[1] |
|---|---|---|---|---|---|---|---|
| | | | | | Little White Salmon River to Bonneville Dam | Bonneville to Estuary | |
| LWS Spring Chinook salmon | 162 | 400,000 | 140 (18.8) | .86 | 3 | 26.5 | 12.4 |

[1] Fish Passage Center, last accessed: September 30, 2020 (10-year average Bonneville forebay temperature from April 15 to May 25th.

Table 5. Hatchery fish parameter values for the LWS NFH spring Chinook salmon releases for the PCD Risk model, starting at Bonneville Dam through to the estuary.

| Program | Number of Hatchery Fish Survived to McNary Dam | Mean sizes in mm (SD) | Survival Rates (mean for Bonneville to mouth[1]) | Travel (residence) Time (days) | Temperature (°C) at Bonneville Dam (mean[2]) |
|---|---|---|---|---|---|
| LWS Spring Chinook salmon | 344,000 | 140 (18.8) | .86 | 26.5 | 12.4 |

[1] Survival rate of hatchery fish from release to Bonneville Dam was used as surrogate by assuming that survival rate of hatchery fish is the same through the estuary as it is to the Bonneville Dam because we have no other survival data.

[2] Fish Passage Center, last accessed: September 30, 2020 (10-year average Bonneville forebay temperature from April 15 to May 25th.

We conducted model runs with natural-origin fish numbers at the point where all possible hatchery-origin fish interactions are exhausted at the end of each day. In doing this, we erred on the side of running the models with natural-origin juvenile abundances that exceed actual numbers available. Using natural-origin juvenile numbers in this manner, at the point where all possible hatchery-origin fish interactions are exhausted at the end of each day, allows us to estimate worst-case impacts on listed natural-origin fish.

The exception to this is for sockeye salmon because we have data for natural-origin abundance for the one population that composes the entire ESU that demonstrates that, from 2006-2016, the maximum number of natural-origin sockeye salmon produced was ~61,000 (Kozfkay 2017). This ESU makes up approximately 2% of the estimated 2.9 million sockeye salmon juveniles entering the Columbia River (Zabel 2015; 2017), thus, we used 3,050,000 (61,000/0.02) as the natural-origin sockeye salmon abundance within the mainstem corridor in the model.

The resulting juveniles lost from release to Bonneville Dam for all natural-origin species are summarized in Table 6. The lost Chinook salmon juveniles is a combination of 6,596 subyearlings and 9,009 yearlings. The resulting juveniles lost from Bonneville Dam through the estuary are summarized in Table 7. The lost Chinook salmon juveniles for this stretch is a combination of 32,981 subyearlings and 44,789 yearlings. Using the smolt-to-adult survival rate (SAR) representative of each species, these lost juveniles equate to 373 Chinook salmon, 57 steelhead, 7 sockeye salmon, 624 chum salmon, and 794 coho salmon adult equivalents (Table 6 and Table 7) from release to the mouth of the Columbia River.

Table 6. Maximum numbers of juvenile natural-origin salmon and steelhead lost to predation (P), competition (C), and delayed mortality (D) from hatchery-origin spring Chinook salmon for model runs from release to Bonneville Dam.

| Program | Release Site | Chinook Salmon[1] | | | Steelhead[2] | | | Sockeye Salmon[3] | | | Coho Salmon[4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P | C[5] | D[6] | P | C[5] | D[6] | P | C[5] | D[6] | P | C[5] | D[6] |
| LWS NFH Spring Chinook salmon | Columbia River (RM 162) | 0 | 0 | 15,605 | 0 | 0 | 420 | 0 | 0 | 8,224 | 0 | 0 | 4,585 |
| Total | | 15,605 | | | 420 | | | 8,224 | | | 4,585 | | |
| SAR[7] | | 0.0041 | | | 0.017 | | | 0.005 | | | 0.0198 | | |
| Adult Equivalents | | 64 | | | 7 | | | 1[8] | | | 91 | | |

[1] The Chinook salmon lost here includes age 0 and age 1 fish from the mouth of the Little White Salmon River to Bonneville Dam.
[2] The steelhead lost here includes age 2 fish from the mouth of the Little White Salmon River to Bonneville Dam.
[3] The sockeye salmon lost here includes age 1 and 2 fish from the mouth of the Little White Salmon River to Bonneville Dam.
[4] The steelhead lost here includes age 2 fish from the mouth of the Little White Salmon River to Bonneville Dam.
[5] Competition, as used here, is the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This is not reality, but does provide a maximum mortality estimate using these parameter value.
[6] Delayed mortality, as used here, is equal to the proportion of a fish's weight loss. For example, if a fish has lost 10% of its body weight due to competition and a 50% weight loss kills a fish, then it has a 20% probability of delayed death, (0.2 = 0.1/0.5).
[7] SAR for Chinook salmon (average of: Grant County PUD et al. 2009; NMFS 2016), steelhead (NMFS 2017b), sockeye (IDFG 2012), and Coho Salmon (ODFW 2011).
[8] Adjusted to represent the proportion of Snake River Sockeye salmon impacts (total estimated impacts times proportion Snake River sockeye (2%)).

Table 7. Maximum numbers of juvenile natural-origin salmon and steelhead lost to predation (P), competition (C) and delayed mortality (D) with hatchery-origin spring Chinook salmon from the LWS NFH for model runs from Bonneville Dam through the estuary.

| Program | Chinook salmon[1] | | | Steelhead[2] | | | Sockeye salmon[3] | | | Chum salmon[4] | | | Coho salmon[5] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | C[6] | D[7] | P | C[6] | D[7] | P | C[6] | D[7] | P | C[6] | D[7] | P | C[6] | D[7] |
| LWS NFH Spring Chinook salmon | 0 | 28 | 77,780 | 0 | 0 | 2,934 | 0 | 0 | 60,149 | 0 | 0 | 159,964 | 0 | 0 | 33,504 |
| Total | 77,808 | | | 2,934 | | | 60,149 | | | 159,964 | | | 33,504 | | |
| SAR[9] | 0.0041 | | | 0.017 | | | 0.005 | | | .0039 | | | 0.0198 | | |
| Adult Equivalents | 319 | | | 50 | | | 6[10] | | | 624 | | | 703 | | |

[1] The Chinook salmon lost here includes age 0 and age 1 fish.
[2] The steelhead lost here are only age 2 fish.
[3] The sockeye salmon lost here includes age 1 and age 2 fish.
[4] Chum salmon lost here are only age 0 fish.
[5] The coho salmon lost here are age 2 fish.
[6] Competition, as used here, is the number of natural-origin fish lost to competitive interactions assuming that all competitive interactions that result in body weight loss are applied to each fish until death occurs (i.e., when a fish loses 50% of its body weight). This is not reality, but does provide a maximum mortality estimate using these parameter values.
[7] Delayed mortality, as used here, is equal to the proportion of a fish's weight loss. For example, if a fish has lost 10% of its body weight due to competition and a 50% weight loss kills a fish, then it has a 20% probability of delayed death, (0.2 = 0.1/0.5).
[8] Summer/fall and fall Chinook subyearlings are not likely to interact with chum and coho salmon because the chum and coho salmon would already be emigrated out of the freshwater system before the subyearlings reach White Salmon River (where chum and coho salmon would spatially overlap with the hatchery releases).
[9] Smolt-to-adult survival rate for Chinook salmon (average of: Grant County PUD et al. 2009; NMFS 2016; 2017c; 2017d), steelhead (average of: NMFS 2017b; 2017d; 2017c), sockeye (IDFG 2012), chum (Hillson 2015), and coho salmon (ODFW 2011).
[10] Adjusted to represent the proportion of Snake River Sockeye salmon impacts (total estimated impacts times proportion Snake River sockeye (2%)).

Table 7 summarizes the likely number of adults that would be lost from each species between Bonneville Dam through the estuary. While these numbers represent the maximum potential effect from the proposed increase in releases, these ecological interactions also occur between natural-origin species; thus, the effects attributable to the proposed increase are only that portion that exceeds the natural level of ecological interactions. For example, the Chinook salmon lost due to ecological effects between release and the estuary includes both listed and non-listed fish, only a portion of the lost adult Chinook salmon equivalents are likely to be listed. However, our analysis assumes that all Chinook salmon lost are listed in order to represent an absolute maximum total (and in the absence of more precise data). In addition, the SAR for subyearlings tends to be lower than for yearlings, so adult equivalents for subyearlings may actually be lower than what was calculated in Table 7. We also assume that the effects on each population within each ESU is proportional to their ESU composition. For example, if a single population represents 5 percent of the natural-origin adults, then the loss our model predicts would be some percentage of the 5 percent contribution of that population to the ESU. These assumptions would also apply to the other listed species as well.

Impacts on listed species may be less because we assumed in our analysis that the fish would continue to travel at the same rate below Bonneville Dam as the rate from release to Bonneville Dam. This assumption likely overestimates the effect these fish would have on natural-origin fish below Bonneville Dam because these hatchery-origin fish are likely to be traveling quicker as they get closer to the mouth of the Columbia River. For example, fall Chinook salmon released from the Spring Creek NFH released directly into the mainstem Columbia River five miles upstream from the mouth of the Little White Salmon River, on average, take just one day to travel from release to Bonneville Dam (Dammerman et al. 2016). These fall Chinook salmon are released in April similar to the LWS NFH spring Chinook salmon. The Spring Creek NFH fall Chinook salmon migrate at a rate of 21.8 miles per day, and at this rate would reach the mouth of the Columbia River in 6.7 days once passing Bonneville Dam. The assumed migration rate for the LWS spring Chinook salmon is 5.5 mile per day and thus it would take 26.5 days to reach the mouth of the Columbia River. At this rate the modeled loss of chum salmon below Bonneville Dam was the equivalent of 624 adults. If the rate of travel observed for the Spring Creek fall Chinook salmon is used in the model, then the modeled loss of chum salmon below Bonneville Dam is the equivalent of only 158 adults.

To understand the potential effect on each Chinook ESU, we calculated the likely number of adults that would be lost from each ESU between release to Bonneville Dam () using the percent of listed wild yearlings (96) and subyearlings (4), and proportion of each attributable to each listed ESU at McNary Dam (taking the average of values from 2012 through 2016; Table 7a of: Zabel 2013; 2014a; 2014b; 2015; 2017). We then applied a similar methodology at Tongue Point (i.e., mouth of the Columbia River) for the reach from McNary Dam to the Columbia River mouth, where 27 percent of listed Chinook salmon are likely to be yearlings, while 73 percent of listed Chinook salmon are likely to be subyearlings, to be able to estimate ESU level loss (taking the average of values from 2012 through 2016; Table 7a of: Zabel 2013; 2014a; 2014b; 2015; 2017). In addition, we applied the ratio of UCR spring Chinook salmon returns compared to the UCR summer/fall Chinook salmon returns (0.24) in order to calculate the UCR spring Chinook salmon adult equivalent for each segment of the run (9 and 1, respectively) to better estimate the effect on UCR Spring Chinook Salmon ESU.

Table 8, summarizes the modeling results showing the potential maximum number of adults lost due to the proposed increase in hatchery spring Chinook salmon releases. From the last column in Table 8, the proposed increase in releases would generally have a less than one percent impact on future adults abundances for ESA-listed populations. The exception is for Columbia River chum salmon where the modeled impact was estimated to be 3.3 percent. The model results assumed a 100 percent overlap between the hatchery spring Chinook salmon and the natural-origin chum salmon below Bonneville Dam. The impacts to chum salmon would be expected to be less due to the outmigration timing observed for natural-origin chum salmon in the lower Columbia River. Juvenile monitoring in Duncan Creek a tributary below Bonneville Dam has found that on average 62% of the juveniles have emigrated into the Columbia River by the end of March (Hillson et al. 2017). The monitoring of juveniles in the Grays River, a tributary near the mouth of the Columbia River, has shown that on average 73% percent of the juveniles emigrate by the end of March (Hillson et al. 2017). These two groups are representative of the two largest populations in the CR Chum Salmon ESU. Using this information, it is my opinion, that actual impacts on CR chum salmon would at least one third those that were modeled, or about 208 adults of about 1.1 percent. The actual impacts are probably substantially less considering that the majority of the hatchery spring Chinook salmon would not reach the lower mainstem Columbia River before the beginning of May, further reducing the overlap and potential for interactions with natural-origin chum salmon juveniles.

Based on the analysis above, the additional production would not be expected to increase impacts beyond those evaluated in the 2007 Opinion, because hatchery operations would not change, straying would remain at the observed very low levels, and ecological interactions would be expected to have no perceptible impacts on listed species.

DRAFT

Table 8. Maximum total ESA-listed natural-origin adult equivalents lost through competition and predation with juvenile hatchery fish by ESU/DPS compared to returning adults of respective ESU/DPS.

| Listed Species (ESU/DPS) | | Percent Yearlings at Bonneville Dam | Yearling AEs from Release to Bonneville Dam | Percent subyearlings at Bonneville Dam | Subyearling AEs from Release to Bonneville Dam | Percent Yearlings at Tongue Point | Yearling AEs from Bonneville Dam to Tongue Point | Percent Subyearlings at Tongue Point | Subyearling AEs from Bonneville Dam to Tongue Point | Total Lost AEs | Total Adults at Mouth of Columbia River | Percentage of Lost Adults to Total Adults at Mouth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chinook Salmon | Total | 100 | 37 | 100 | 27 | 100 | 184 | 100 | 135 | 383 | 141,728 | 0.5 |
| | Snake River Spring/Summer Chinook Salmon ESU | 27.7 | 10 | 0 | 0 | 26.0 | 48 | 0 | 0 | 58 | 32,823[3] | 0.2 |
| | Snake River Fall Chinook Salmon ESU | 0 | 0 | 1.5 | <1 | 0 | 0 | 4 | 5 | 5 | 23,198[4] | 0 |
| | UCR Spring Chinook Salmon ESU | 70.1 | 6[1] | 0 | 0 | 4.9 | 2[2] | 0 | 0 | 8 | 5,064[5] | 0.2 |
| | Lower Columbia River Chinook Salmon ESU | 1.9 | 1 | 98.6 | 26 | 32.6 | 60 | 96 | 130 | 217 | 38,464[6] | 0.6 |
| | Upper Willamette River Spring Chinook Salmon ESU | 0 | 0 | 0 | 0 | 36.5 | 67 | 0 | 0 | 67 | 9,356[7] | 0.7 |
| Steelhead | Total | 100 | 7 | 0 | 0 | 100 | 50 | 0 | 0 | 57 | 115,833 | 0 |
| | Snake River Steelhead DPS | 4.6 | 0 | 0 | 0 | 47 | 24 | 0 | 0 | 24 | 54,414[8] | 0 |
| | UCR Steelhead DPS | 17.9 | 1 | 0 | 0 | 6 | 3 | 0 | 0 | 4 | 6,929[8] | 0 |
| | Middle Columbia Steelhead DPS | 70.1 | 5 | 0 | 0 | 19.2 | 10 | 0 | 0 | 15 | 22,300[8] | 0 |

DRAFT

| Listed Species (ESU/DPS) | | Percent Yearlings at Bonneville Dam | Yearling AEs from Release to Bonneville Dam | Percent subyearlings at Bonneville Dam | Subyearling AEs from Release to Bonneville Dam | Percent Yearlings at Tongue Point | Yearling AEs from Bonneville Dam to Tongue Point | Percent Subyearlings at Tongue Point | Subyearling AEs from Bonneville Dam to Tongue Point | Total Lost AEs | Total Adults at Mouth of Columbia River | Percentage of Lost Adults to Total Adults at Mouth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lower Columbia River Steelhead DPS | 7.7 | 1 | 0 | 0 | 19 | 10 | 0 | 0 | 11 | 22,031[8] | 0 |
| | Upper Willamette River Steelhead DPS | 0 | 0 | 0 | 0 | 8.8 | 4 | 0 | 0 | 4 | 10,159[8] | 0 |
| Snake River Sockeye Salmon ESU | | 100 | 1 | 0 | 0 | 100 | 6 | 0 | 0 | 7 | 1,623[9] | 0.4 |
| Columbia River Chum Salmon ESU | | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 624 | 624 | 18,498[10] | 3.3 |
| Lower Columbia River Coho Salmon ESU | | 0 | 91 | 0 | 0 | 100 | 0 | 0 | 703 | 794 | 267,060[11] | 0.3 |

[1] We accounted for effects on the listed UCR Spring Chinook Salmon ESU from our model by applying the total Chinook adult equivalents to Bonneville Dam from the UCR by the ratio of UCR spring Chinook salmon to UCR River summer Chinook salmon. This was calculated by summing the average total return (hatchery and natural) of UCR spring Chinook salmon (Table 8 of ODFW and WDFW 2016) and the total return of summer Chinook salmon (Table 10 of ODFW and WDFW 2016) from 2011-2015, and then dividing the total UCR spring Chinook return into this sum. We then applied this average proportion (0.24) of UCR spring Chinook to the total number of UCR Chinook salmon adult equivalents estimated to be lost from our model analysis (781).

[2] We accounted for effects on the listed UCR Spring Chinook Salmon ESU from our model by applying the total Chinook adult equivalents from Bonneville Dam to the mouth of Columbia River by applying the ratio of UCR spring Chinook salmon to UCR River summer Chinook salmon described above (0.24) to the total number of UCR Chinook salmon adult equivalents estimated to be lost from our model analysis (18).

[3] This number was obtained by taking the average number of wild adult returns to the Columbia River from 2011 to 2015 from Table 9 of ODFW and WDFW (2016).

[4] This number was obtained by taking the average number of adult returns to the Columbia River from 2011 to 2015 from Table 5 of WDFW and ODFW (2017).

[5] This number was obtained by taking the average number of wild adult returns to the Columbia River from 2011 to 2015 from Table 8 of ODFW and WDFW (2016).

[6] This number was obtained by taking the average of the sum of the estimated number of Lower Columbia River fall bright Chinook salmon, fall tule Chinook salmon, and spring/summer Chinook salmon for 2011 to 2015. The fall bright Chinook salmon numbers were obtained by summing the total natural spawner abundance estimates of each population from Tables 2.1.12 through 2.1.14 of TAC (2017) from 2011 to 2015. Then, we accounted for harvest impacts using LRH impact numbers of sport and commercial fisheries from the respective (Table 9 of TAC 2012; Table 12 of TAC 2013; Table 16 of TAC 2014; Table 17 of TAC 2015; Table 18 of TAC 2016). The fall tule Chinook salmon numbers were obtained from Table 4 of WDFW and ODFW (2017) by using the 2011 to 2015 actual return numbers for the Lower River Wild stock. The spring/summer Chinook salmon numbers were obtained by summing the total natural spawner

abundance estimates of each population from Tables 2.1.10 and 2.1.11 of TAC (2017) from 2011 to 2015. Then, we accounted for harvest impacts using the total impact of the Upper Willamette River spring-run Chinook salmon fishery from the respective years (Table 88 of NMFS 2017a) as a surrogate.
[7] This number was obtained by taking the average number of estimated natural-origin returns to the Columbia River mouth from 2011 to 2015. For each year, the natural-origin returns number was estimated by multiplying the projected spring Chinook run size by the percent of unmarked fish (100 minus total mark rate) obtained from http://www.dfw.state.or.us/fish/fish_counts/willamette/archives.asp, last accessed on October 30, 2017.
[8] To obtain these numbers, we summed the total wild summer steelhead returns (Table 6 of WDFW and ODFW 2017) and total wild winter steelhead returns (Table 11 of ODFW and WDFW 2016) for 2011 to 2015, then applied the proportions of DPS obtained from Zabel (2013; 2014a; 2014b; 2015; 2017), described above.
[9] This number was obtained by taking the average number of Snake River sockeye returns to the Columbia River from 2011 to 2015 from Table 18 of ODFW and WDFW (2016).
[10] This number was obtained by taking the average number of total Columbia River Chum abundance from Table 12 of WDFW and ODFW (2017).
[11] This number was obtained by taking the average number of total coho salmon returns minus hatchery coho returns; Table 8 in WDFW and ODFW (2017).

Daly, E. A., J. A. Scheurer, R. D. Brodeur, L. A. Weitkamp, B. R. Beckman, and J. A. Miller. 2014. Juvenile steelhead distribution, migration, feeding, and growth in the Columbia River Estuary, plume, and coastal waters. Marine and Coastal Fisheries. 6(1): 62-80.

Dammerman, K. J., D. Hand, D. Olson, J. Poirier, S. Pastor, and J. Rivera. 2016. Monitoring and Evaluation Updates for John Day/The Dalles Dam Mitigation Programs at Spring Creek and Little White Salmon National Fish Hatcheries. FY 2016 Annual Report. October 2016. USFWS, Vancouver, Washington. 26p.

Grant County PUD, WDFW, and YN. 2009. Upper Columbia River Spring-run Chinook Salmon, Nason Creek Supplementation Program HGMP. September 15, 2009. 98p.

HETT. 2014. NTTOC.accdb. (database for NTTOC simulations). Douglas County Public Utility District ftp site.

Hillson, T., K. Bentley, D. Rawding, and J. Grobelny. 2017. Lower Columbia River Juvenile chum Salmon Monitoring: Abundance estimates for chum, Chinook, coho, and steelhead. April 2017. FPT 17-02. 630p.

Hillson, T. D. 2015. Chum Salmon Enhancement in the Lower Columbia River – Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam. Grays River Chum Salmon Enhancement Program Brood Years 2013 and 2014. Project # 2008-710-00. BPA, Portland, Oregon. 59p.

IDFG. 2012. Snake River Sockeye Salmon Captive Broodstock, Research and Production HGMP.

Kozfkay, C. 2017. Outmigration total for natural-origin sockeye salmon_IDFG excel report. August 3, 2017.

NMFS. 2007. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation. USFWS Artificial Propagation Programs in the Lower Columbia and Middle Columbia River. November 27, 2007. NMFS Consultation No.: NWR-2004-02625. 256p.

NMFS. 2016. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Issuance of Four Section 10(a)(1)(A) Permits for Spring Chinook Salmon Hatchery Programs in the Methow Subbasin. October 13, 2016. NMFS Consultation No.: WCR-2015-3845. 116p.

NMFS. 2017a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. NOAA's National Marine Fisheries Service's implementation of the Mitchell Act Final Environmental Impact Statement preferred alternative and administration of Mitchell Act hatchery funding. January 15, 2017. NMFS Consultation No.: WCR-2014-697. 535p.

NMFS. 2017b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Two Steelhead

Hatchery Programs in the Methow River. October 10, 2017. NMFS Consultation No.: WCR-2017-6986. 117p.

NMFS. 2017c. Endangered Species Act Section 7(a)(2) Biological Opinion, Section 7(a)(2) Not Likely to Adversely Affect Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Little White Salmon National Fish Hatchery Upriver Bright Fall Chinook Salmon Program. October 5, 2017. NMFS Consultation No.: WCR-2015-2764. 175p.

NMFS. 2017d. Final Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. December 12, 2017. Nine Snake River Steelhead Hatchery Programs and one Kelt Reconditioning Program in Idaho. NMFS Consultation No.: WCR-2017-7286. 139p.

NMFS. 2019. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska. NMFS Consultation No.: WCR-2018-10660. April 5, 2019. 443p.

ODFW. 2011. Sandy River Coho Salmon Program HGMP. Coho Salmon (Stock 11). May 16, 2011. 78p.

ODFW, and WDFW. 2016. 2016 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and other Species, and Miscellaneous Regulations. January 20, 2016. 101p.

Pearsons, T. N., and C. A. Busack. 2012. PCD Risk 1: A tool for assessing and reducing ecological risks of hatchery operations in freshwater. Environmental Biology of Fishes. 94: 45-65.

TAC. 2012. 2011 TAC Revised Annual Summary Report. Abundance, Stock Status and ESA Impacts, May 31- June 1, 2012. 18p.

TAC. 2013. 2012 TAC Final Annual Summary Report. Abundance, Stock Status and ESA Impacts, May 30-31, 2013. 23p.

TAC. 2014. 2013 TAC Annual Summary Report. Abundance, Stock Status and ESA Impacts, May 29-30, 2014. May 27, 2014. 29p.

TAC. 2015. 2014 TAC Annual Summary Report. Abundance, Stock Status and ESA Impacts, May 13-14, 2015. May 08, 2015. 28p.

TAC. 2016. 2016 TAC Final Annual Report. Abundance, Stock Status and ESA Impacts. 2015 Summary Fisheries and Fish Runs. May 20, 2016. 29p.

TAC. 2017. 2018-2027 *U.S. v. Oregon* Biological Assessment of Incidental Impacts on Species Listed Under the Endangered Species Act Affected by the 2018-2027 *U.S. v. Oregon* Management Agreement. June 21, 2017. 624p.

WDFW, and ODFW. 2017. 2017 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. September 7, 2017. 75p.

Zabel, R. W. 2013. Memo to James Lecky (NMFS) from Richard Zabel (NMFS). January 23, 2013. 2012 Estimation Memo. NWFSC, Seattle, Washington. 75p

Zabel, R. W. 2014a. Memorandum to Donna Wieting (NMFS) from Richard Zabel (NMFS). March 13, 2014. 2013 Estimation Memo. NWFSC, Seattle, Washington. 67p.

Zabel, R. W. 2014b. Memorandum to Donna Wieting (NMFS) from Richard Zabel (NMFS). November 4, 2014. 2014 Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2014. NWFSC, Seattle, Washington. 73p.

Zabel, R. W. 2015. Memorandum to Donna Wieting (NMFS) from Richard Zabel (NMFS). Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2015. October 5, 2015. NWFSC, Seattle, Washington. 72p.

Zabel, R. W. 2017. Memorandum to Christopher Yates (NMFS) from Richard Zabel (NMFS). Updated, Corrected Estimation of Percentages for listed Pacific Salmon and Steelhead Smolts Arriving at various locations in the Columbia River Basin in 2016. January 25, 2017. NWFSC, Seattle, Washington. 75p.